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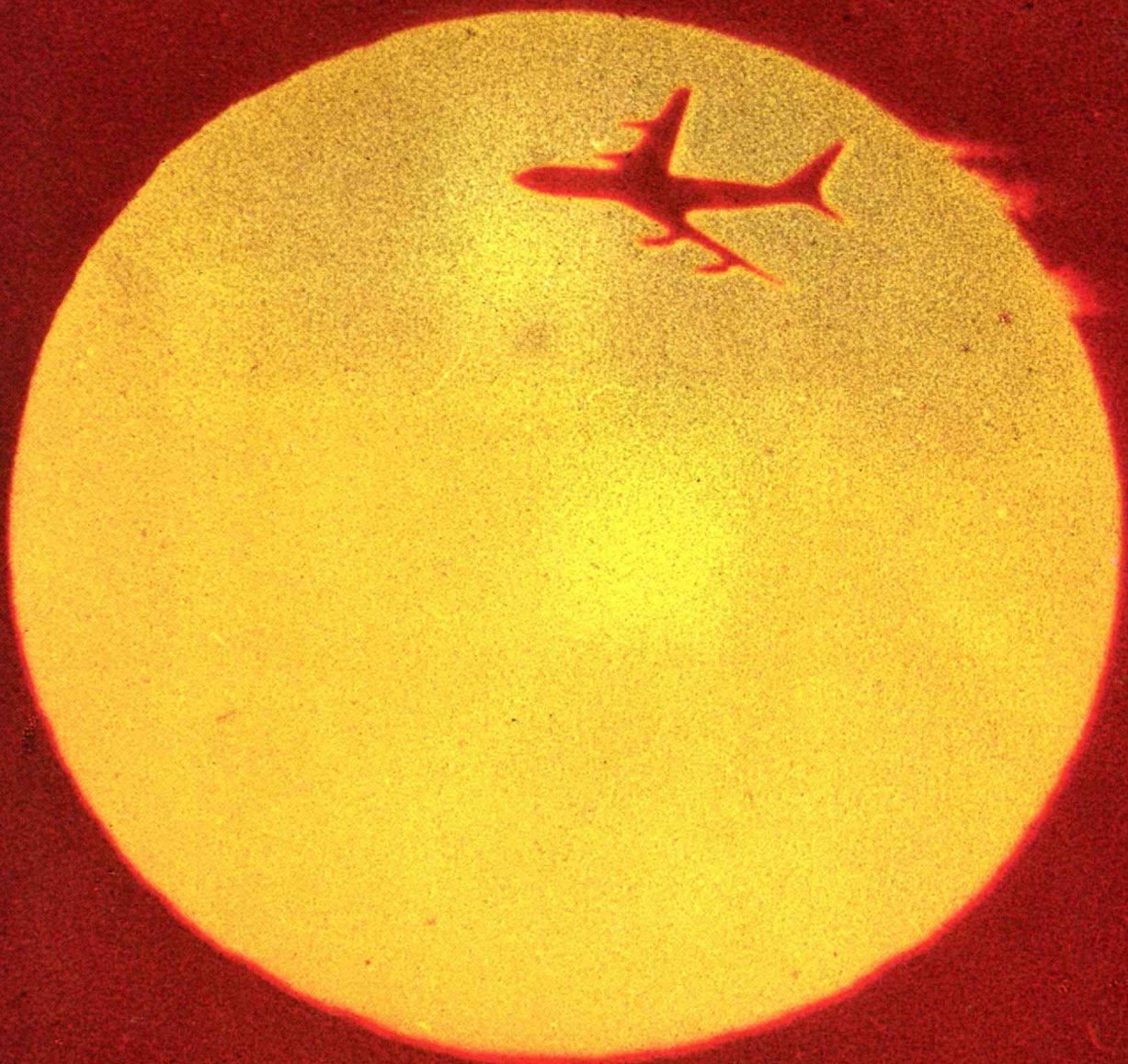
Technology Review



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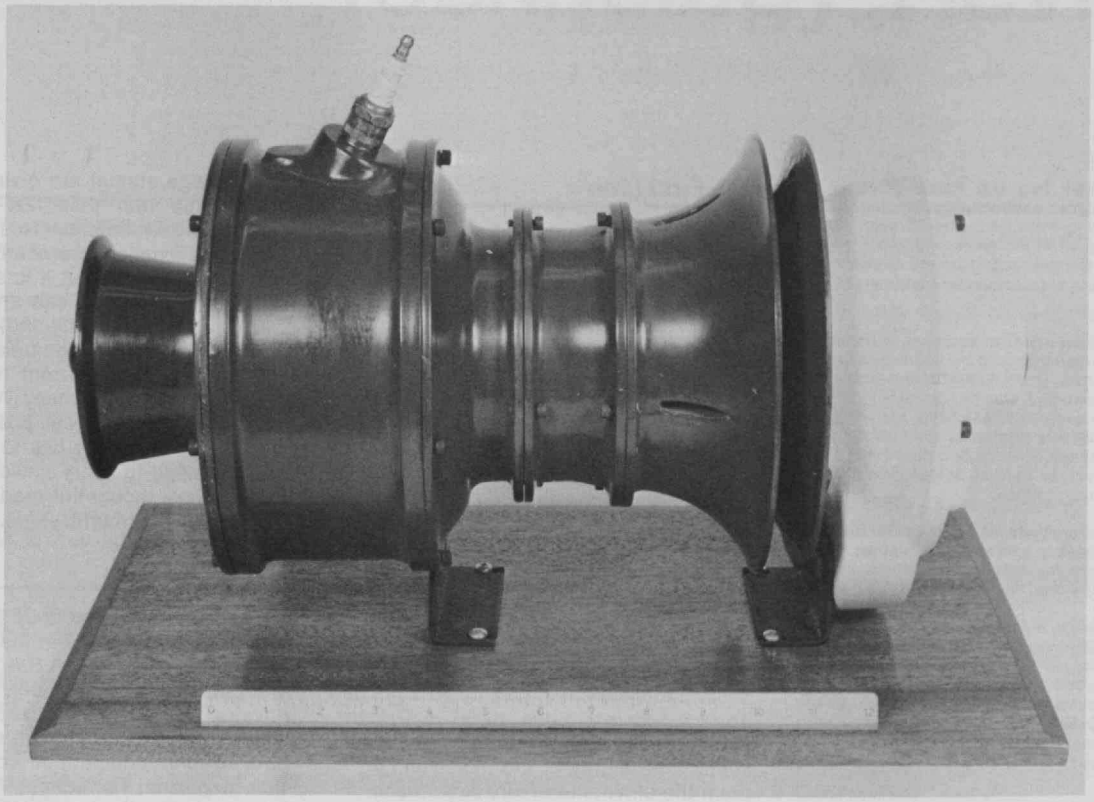

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The First Line

A reader of *Technology Review* has recently written his alma mater to suggest that colleges and universities have lost their sense of place, that they need not take upon themselves the burden of relieving all injustice and averting all catastrophe. Their task, he says, is to educate; they must prepare young people for useful work, to give intelligent and effective direction to a society whose ills are complex and little yielding.

He is right, of course. But here lurks danger. For the universities, more than any other institutions in our lives, are the primary sources of our intellectual power, our aesthetic sense, and our understanding of humanity. When one becomes suddenly committed to eradicating old shortcomings, he necessarily sets his new goals higher and turns away from methods and institutions with which he associates the failures of the past. Among them the universities? Are Americans losing faith in their colleges?

The question is posed rhetorically by Editorial Projects for Education, Inc., an organization growing out of university magazine publishing in which this Editor is privileged to participate, in its current annual report on higher education. E.P.E.'s answer: Yes . . . a profoundly disturbing symptom of the times in which we live.

The mischief does not come from the radical activist who capitalizes on the vulnerability of the university as an institution devoted to freedom of knowledge and thought. It does not come from the alumnus—his number is few—who fails to understand his institution's vulnerability, perceiving instead weakness which he cannot condone or support. It does not come from the shallow professor—though he is too many—who uses his lecture and privilege for academic nonsense. The mischief comes from so many of us that Rhode Island's distinguished Congresswoman Edith Green observed during the last session of Congress that "it would be unwise to try to bring to the floor this year a bill on higher education, because the climate is so unfavorable."

More college alumni are giving to their schools this year than last—probably more than ever before. (Their gifts are sometimes smaller in amount, but so are their pocketbooks.) But it is also true that a California legislator can argue that "the public has clearly indicated displeasure with higher education." The fact is, as E.P.E.'s current report says so eloquently, "Too many Americans have forgotten the great positive contributions of the universities to this nation." The challenge to every university alumnus, to every thoughtful reader, is to help set the record straight.—J.M.

The Cover

The cover photograph is by Water A. Feibelman, a physicist at the Goddard Spaceflight Center (N.A.S.A.). It was first published in December, 1970, in *Physics Today* as first prize in the "physics and environment" category of a photographic competition conducted by that magazine. *Technology Review* uses it to symbolize the issues of environmental monitoring discussed in this issue by George D. Robinson (see pp. 18-27).

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Science Review
Robert C. Cowen

In this magazine last month, two astronomers discussed the prospects for a new science called astrochemistry. Here is a science writer's interpretation of the subject of their report, and what may be its significance

Biochemistry in Space?

One of the professional amusements of science writers is to watch sober-sided specialists sidle up to the more romantic notions in their field. Embarrassed to be caught with idle fancies, they first treat such concepts as a joke, then as harmless speculation. Finally, when the tide of discovery runs strongly, they start taking such things seriously.

So it has been with the notion of bioclouds. These would be masses of interstellar dust and gas enriched with amino acids and other organics associated with life.

Astronomers have had indigestion enough the past three years assimilating the fact that complex organic molecules of any kind can exist in interstellar space. It completely soured the stew to suggest that precursors of life may originate there rather than having to arise in an established planetary environment. This is to say nothing of the fantasia that life processes or life-like processes might be responsible for some of the celestial organics. In the last issue of the *Review,* two astronomers related the details of this remarkable extension of knowledge in their field which has occurred since 1968 (*see "From Radio Astronomy Towards Astrochemistry" by David Buhl and Lewis E. Snyder,* Technology Review *for April, pp. 54-62).*

However, discovery of interstellar formic acid (found in ants and stinging nettles on earth) and methyl (wood) alcohol, reported late last year, drove home the point that very complex organic chemistry goes on between the stars. Given this and the fact that some of the organics discovered are themselves precursors of amino acids, even the conservatives now admit the possibility of bioclouds. Their discovery could come at any time. When it is announced with unambiguous supporting data, it will be the most impressive, albeit circumstantial, evidence yet for the universality of life.

An Ongoing Chemistry of Life?

Just to admit this as a possibility represents a revolution in astronomical thought. While astronomers have believed that life could arise on other planets orbiting other suns, they gave scarcely a thought to the possibility that some of the relevant chemistry might be taking place before even the planets themselves formed.

Astronomers have been aware of a few diatomic combinations in space since they were identified optically in the 1930's and 1940's. One more—the hydroxyl radical—was added to the list in the early 1960's. The old astronomical outlook could live with such two-atom species. They resist radiative destruction. Their existence didn't challenge the notion that interstellar conditions, even in dust and gas clouds, are hostile to molecular complexity. As the two authors in last month's issue of the *Review* have remarked, the possibility of more complex molecules existing simply was "beyond imagination."

In 1968, the unimaginable began to appear when a Berkeley team picked out radio lines of ammonia. Since then, as Dr. Buhl and Dr. Snyder chronicled, the total has risen to five space organics known at this writing with others expected to be found any time.

Radiation, Absorption, or Emission?

As far as what astronomers know about the interstellar environment, these molecules still seem a bit "unimaginable." Radiation, ultraviolet in particular, should tear them apart. Most of them seem to exist in dark interstellar clouds which could shield them from such destruction. In that case, the molecules should condense rather quickly onto the dust grains; but under these conditions you might expect them to be too cold and closely held to emit detectable radio spectra. Indeed, the interstellar dust may be a catalyst for the molecules' formation, which no one has yet satisfactorily explained.

The radio emissions, as opposed to absorption lines, are particularly puzzling. Hydroxyl and water concentrations seem to act as natural masers, as Dr. Buhl and Dr. Snyder explained. Their emissions are very powerful. They come from astronomically tiny volumes. Some of these are less than an astronomical unit across. Some volumes may even be as small as a star or large planet. While a maser-like process seems the best explanation of powerful emissions of such small masses, no one knows what pumps the masers.

The excitation of other radio emitters might arise from absorption and reemission of the universal background radiation. This is a bath of radio energy that appears to pervade the universe. At many wavelengths it fits the emission spectrum of a black body with a temperature 3° above absolute zero. The trouble is, a molecule like ammonia should come into equilibrium with this background in about a year with a temperature too low to be detected by radio from earth. So if the background radiation energizes the molecules, it's not an equilibrium process. Perhaps collisions with neutral molecules, such as the hydrogen that's also been found between the stars, could be a stimulus. Right now, the whole subject is an open question.

New Tools for Galactic Research

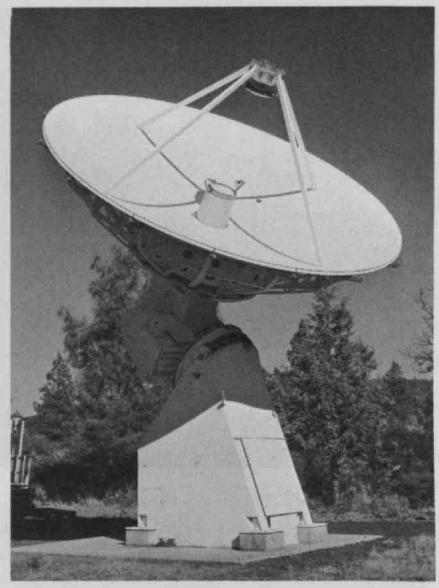
For some purposes, though, astronomers don't care where the molecules come from or what energizes them. Because they're there they provide handy new tools to explore our galaxy.

For example, at the Max Planck Institute of Radio Astronomy at Bonn, Germany, T. L. Wilson has been using formaldehyde absorption lines to range the distances to 14 supernovae remnants. These exploded in the spiral arm closest to the galaxy's nucleus. The galaxy rotates differentially, as does a whirlpool. This means that the relative velocity of distant objects to our sun depends on their distance from the sun. From the absorption spectra, Dr. Wilson could make Doppler-shift estimates of the velocities of the supernovae remnants. From these he could deduce distances. And from the distances he could estimate such things as the size and intrinsic brightness of the remnants.

Similar Doppler-shift measurements, both in emission and absorption, can be used to map motions of interstellar matter. Already, some formaldehyde data suggest a series of rotating rings toward the galactic center. The outer ones seem to be expanding while the inner ones contract.

There may even be opportunities to map distributions of some isotopes around the

The 20-ft. telescope at Hat Creek, Calif., built by W. J. Welch and D. D. Thornton of the University of California at Berkeley, was instrumental in the discovery of interstellar water and ammonia—the 1968 discoveries which, in the words of David Buhl and Lewis E. Snyder, "opened a Pandora's box of possibilities concerning the chemistry of interstellar space."



galaxy. As Dr. Buhl and Dr. Snyder reported, sparse formaldehyde measurements show a ratio of oxygen isotopes 16 and 18 close to that of earth rather than that which prevails in stars. Measurements on carbon isotopes 12 and 13 in several different space chemicals sometimes show ratios close to that on earth, 89, and sometimes ratios as low as 2. Here is yet another puzzle to add to the molecule mystery. Why should some isotope ratios be "terrestrial" rather than cosmic? Why should there be such a wide range among the carbon ratios?

The whole field, with its rush of discovery, its perplexing questions, and its shock to preconceived notions, reminds you of the discoveries of pulsars and quasars. But there's a significant difference. Pulsars and quasars appear to involve energy processes unknown to physicists before. The interstellar molecules should be explicable in familiar physical and chemical terms. This may, however, call for some radical rethinking about the kind of chemistry that interstellar conditions allow.

Panspermia Renewed

This is where the field acquires a romantic tinge. For whatever the chemistry may be, it seems to favor organic molecules, some of which have a biologically interesting nature. Depending on the astronomer's temperament, this can be an interesting, perhaps annoying, oddity or it can be a takeoff point for speculation.

When the subject came up at the International Astronomical Union triennial conference at Brighton last summer, the chairman of a molecule session, G. H. Herbig of Santa Cruz, clamped down on biological speculations. He remarked tartly that astronomers had enough to account for without trying to cope with fantasies. He observed that "we have in the chondrite meteorites [which contain amino acids] an example of how ingenious nature can be in forming organic molecules under space conditions without biological aid."

Carl Sagan of Cornell University later took a dig at this conservatism. The range of molecules so far discovered does seem to show a peculiar selectivity, he noted. Observers rarely see molecules closely related to those already discovered. Normally, Dr. Sagan said he would expect to find different versions of a particular molecular type, versions formed by replacing one atom or subgroup of the molecule with a different atom or subgroup. The "selectivity" of the space molecules reminds him of the selectivity seen in biochemical systems. He finds it hard to understand this selectivity without assuming some kind of biochemical connection "which the chairman has ruled out."

However, most of the speculators find romance enough in the thought that life's precursors may arise out there among the stars whether or not anything we would recognize as biochemistry is involved. Certainly amino acids can arise from ammonia and formaldehyde, at least in laboratory experiments which admittedly do not simulate space conditions. And equally certainly, amino acids can arise under space conditions in our solar system, to judge from their discovery in terrestrially uncontaminated meteorites. Why not, then, expect such life-related compounds to arise in interstellar space when such "raw materials" as ammonia and formaldehyde have already been found there?

Commenting on this in the journal *Science,* Bertram Donn of the Goddard Space Flight Center says, "As star and planet formation take place throughout the galaxy, these carbon compounds may play an important role in chemical evolution and the origin of life. This is a phase of the study of the origin of life which has generally been disregarded." Even such cautious observers as Dr. Snyder and Dr. Buhl think the interstellar medium may well contain amino acids, perhaps glycine and alanine. "Arguments against the existence of so-called bioclouds are not as strong as they seemed to be only two years ago," they have noted.

Perhaps, indeed, a young planet starts off endowed with chemical raw materials for life. Perhaps these do not have to arise, planet by planet, through local evolution. It may be that, in this modified form, the old theory of panspermia, the seeds of life pervading space, will be found to be true after all.

Robert C. Cowen is Science Editor of the Christian Science Monitor. *An alumnus of M.I.T. and a regular contributor to the* Review, *his columns have for the last two years come from London. Now his base of operations is being transferred to Washington, D.C., from whence he will be reporting in future issues.*

European Report
William E. Jahsman

Student (and faculty) unrest is an international phenomenon. Its results in Europe will be greater democracy in university governance and greater homogeneity in European institutions—in many respects a larger revolution than any foreseen for American higher education

Reforming the European University

A common bond among institutions of higher learning these days is the problem of student unrest. In Europe, demonstrations and disorders erupted first on German and French campuses and then fanned out to include Italy and England. No serious problem of this kind yet exists in the eastern European countries.

Because of the variations in the educational processes in the countries affected, reasons for the disorders differ. But the ultimate effect of these protests will be the same everywhere. There will be more democratic forms of university government with direct student participation, and there will be greater homogeneity in education throughout Europe. The latter will be the result of international communication among both students and faculty for the purpose of comparing advantages and faults of Europe's many different systems.

Turmoil has not been restricted to the liberal arts campus; the normally conservative engineering and science student has been infected with the spirit of reformation (if not outright revolution) and has pressed for comparable liberalization in his college.

Student Power at Darmstadt

A leading example of the effect of student power has been the dramatic reorganization of the governing bodies at the Technische Hochschule (Technical University) at Darmstadt. Under the new provisions, membership in the University Council, Senate, and Faculties (roughly, departments), originally the province of full-time teaching staff (instructors through professors), has been enlarged; in addition to the teachers, membership will now also include representatives from among the teaching and research assistants, the students, and the nonscientific staff. As a result these three bodies are now quite heterogeneous in their composition, and all views in the political and academic spectrum are represented.

Overall policy-making responsibility resides in the University Council, which recommends changes in the constitution and elects (and dismisses) the president and vice-presidents. Recommended constitutional changes are subject to approval by the Minister of Educational and Cultural Affairs, usually a mere formality. The Council now numbers over 100 members, with a 30-30-30-10-per-cent distribution among teachers, assistants, students, and nonscientific staff. Full professors constitute less than 25 per cent of the Council, and the presence of the assistants and students has given this body a decidedly liberal caste.

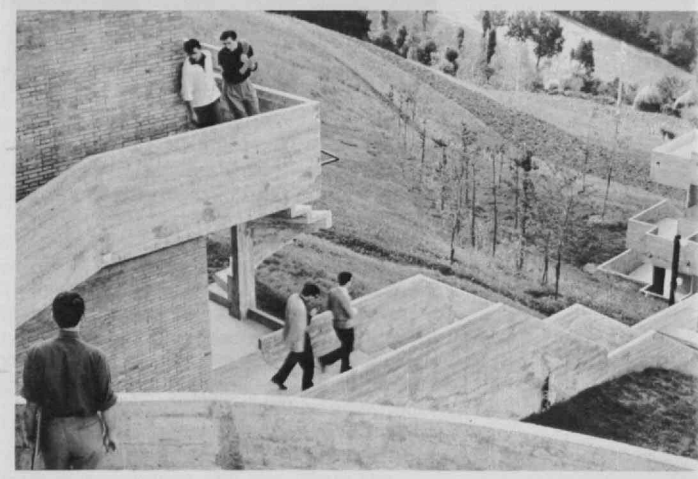
The University Senate is much smaller in number (less than 30) and is responsible for governing the University. Although teachers make up more than one-third of the total group, student representatives hold the veto, the effect of which is to delay approval of any item until the next Senate meeting, when a two-thirds majority is needed to override it. Since the students make up almost one-third of the Senate, overriding their veto may prove difficult.

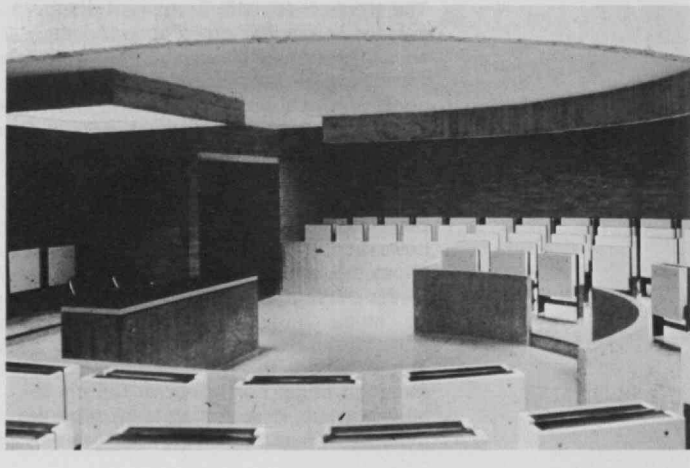
Representation on the Faculties is based on the same formula as the Council, although the students have the veto power as in the Senate. The Faculty is responsible for teaching and research matters within the disciplines it represents (curricula, examinations, etc.) and for electing its Dean (i.e., department chairman). Since all teachers must be members of their faculty, it may be numerically larger than the University Council and is very likely to be unwieldy in operation.

To End the "Terror-Tests"

As might be expected, faculty support for the new constitution was not unanimous; in fact, two separate legal actions were initiated by faculty members to test the state constitutionality of the revisions. One of these, a lawsuit challenging certain wording in the revisions rather than their legality as such, resulted in a State Court ruling last spring which invalidated the new constitution.

Under these conditions, a temporary ruling body composed of the current President and other state officials was appointed by the Court under an *ad hoc* law; the body was empowered not only to carry out the day-to-day operation of the University but also to draw up a set of guidelines for writing a legally unchallengeable constitution. The re-





The modern architecture of these European universities is in sharp contrast to ancient patterns of teaching and governance. At the left, the Cité Universitaire in Paris, the hillside campus of the College of Urbino, and its conference hall. Below, the Berlin Academy of Fine Arts, the Berlin-Charlottenburg Technical University, and the student center of the Technical Hoogschool, Enschede, Netherlands. (Photos courtesy Rotch Library, M.I.T.)

sulting document is expected to bear close resemblance to the constitution which provoked the original legal action, except that the loopholes will be removed and modifications introduced to render it compatible with new federal policy on science and education (for example, professorial chairs having common disciplinary bases will be organized into single departments). That done, the faculty will have to learn to operate within the liberalized environment.

At present, the proposed Darmstadt constitution is the most liberal of any at a European institution. Radical student groups are, in fact, trumpeting that "Darmstadt is world champion in university reform!" Some universities in other countries are already following this pattern. A constitution bearing many similarities to the Darmstadt document was recently established for all Dutch universities, and it has precipitated at least one resignation of a department chairman at the Institute of Technology at Delft.

Pressure for additional reform continues. To keep the pot boiling, students are demanding elimination of admission requirements and of all examinations ("terror-tests"). To demonstrate the seriousness of their demands, several S.D.S. members invaded the Mechanics Institute at Darmstadt during an undergraduate final examination and vocally encouraged the 15 participating students to defy "these archaic and repressive terror tactics" and walk out of the examination hall. Although disruption in the room was complete, proctors quietly spread the word to the exam takers that an alternate room had been found. By following devious routes to avoid attracting attention to themselves, 12 of the 15 succeeded in reaching the alternate location where they completed their examination in peace.

Good-Natured Helplessness

In Italy, reformation day is more distant. It's not that most Italian professors are unwilling to teach or that most students are unwilling to learn; it's just that classrooms and cafeterias are dangerously overcrowded, that the institutes and professorial chairs need reorganization, and that the government, the only body authorized to act on these matters, has difficulty in forming a stable coalition of its own.

Thus a feeling of good-natured helplessness has begun to infect the teaching in the Italian universities, and the paralysis which has periodically affected the government appears to be spreading to the universities as well. Indeed, the senior faculty at the world-famous Milan Polytechnic met at the end of the last academic year to consider taking strike action of its own—probably more an example of strike-envy than evidence of substantial grievance. After all, the professors must have reasoned, the support staff has been on strike for several weeks and the secretarial and janitorial services are slowly grinding to a halt; what better time to press for needed revisions in salary structure and for resolution of the pending reorganization schemes?

At the Naples Polytechnic, on the other hand, it was the students who were responsible for the interruption of classes; after taking a strike vote, they shut down the Polytechnic, an impressive new ten-story building completed just four years ago, simply by barricading the doors. The faculty dutifully respected the picket line, most of them piously hoping that the students' complaints on overcrowding—4,000 enrolled in a building designed to accommodate 1,500—and curriculum deficiencies will precipitate the needed corrective measures.

And so it goes throughout Europe. The educational reformations are still in ferment and the picture is not completely clear. However, it is reasonable to assume that changes will be in the direction of unifying, rather than dividing, the European educational systems.

William E. Jahsman is Professor of Mechanical Engineering at the University of Colorado; this report, the first of two which he will write for Technology Review, *is based on his observations of the European scene while stationed in 1969-70 in the London Branch of the U.S. Office of Naval Research.*

To the dismal history of America's effort to equitably distribute health care, add one more chapter. We still lack both a plan and a plan to implement it

The Year of Health (Without Plan)

Everyone in Washington is suddenly worrying about health. There are health insurance bills, medical manpower bills, cancer control bills. The only thing that is lacking is a national plan for good health.

To wit:

◇ The Nixon administration proposal for nationwide health insurance would fail to insure a large part of the population—though it would assure the health of much of the private insurance industry.

◇ The chief Democratic counterplan so far—the Kennedy-United Auto Workers health bill (these are its main sponsors)—would aim to do more. But, precisely like the administration plan, it is still so vaguely described that it is impossible to say just what it is, or how well it would work.

◇ Both the administration and health forces in Congress are promising a crusade against cancer, while research is languishing on many other diseases whose victims are no less sick or dead. There is almost no research at all on how to improve medical or hospital care. Walter McNerney of Blue Cross points out that the government in 1968 spent $1.6 billion for biomedical research but less than $18 million for research on ways to improve health service delivery.

◇ The country has been paying increasingly large sums for Medicare and Medicaid for five years, yet only now is an administration even beginning to think about improved delivery systems that might lighten the cost. A health specialist for the National Urban League said of the Nixon, Kennedy, and other proposals: "Nowhere in the myriad of bills, resolutions, or plans that have been advanced to date is there any clear mandate to establish and implement with speed any coordinated health system."

At the heart of all this disarray is an almost unbelievable lack of health planning—regular, long-range, and expert—at any point in the great Department of Health, Education and Welfare, which is supposed to be in overall charge of health. Actually, it is impossible in the federal health hierarchy to get an answer to the question: "Who's in charge?" The true answer is: "No one."

1971: A Year of Health

Let's start at this point. This country—unlike European countries which have long had national health systems—has never had a department or ministry or secretary of health. About 20 years ago it sort of coped with the problem by establishing H.E.W.: a Pentagon of do-goodism.

A succession of secretaries have failed to manage this agency's sprawling machinery, and only a few—outstandingly, Wilbur Cohen—have even managed a pretense. Lyndon Johnson's first H.E.W. Secretary, John Gardner, saw some of the problems very clearly; his second, Cohen, moved on them hard. The current secretary, Elliot Richardson, is the most promising Republican Secretary yet, but he is still trying to get hold of the reins.

Health in the United States is a $70 billion a year industry ("the fastest-growing failing business in the nation," as Senator Kennedy likes to say). But the highest health official in the entire Department of Health, Education, and Welfare is not even an undersecretary but Assistant Secretary for Health and Scientific Affairs, one of seven assistant secretaries.

Under a new Nixon reorganization plan, this "health chief" would be submerged even farther. He would become mere "Administrator for Health" under a new Secretary of Human Resources, not to mention three undersecretaries and their own staffs with various bits of the health action.

President Nixon's first H.E.W. Secretary, Robert Finch, at least tried to appoint a good Assistant Secretary for Health, Dr. John Knowles, Director of Massachusetts General Hospital. The late Senator Everett Dirksen opposed Dr. Knowles, and the job long went unfilled. Secretary Finch lost and health lost. The health tasks that had to be done were parceled out or grabbed during the long hiatus by various deputies and "assistants to" the secretary, his undersecretary, or the non-existent assistant secretary.

Finally Dr. Roger O. Egeberg, a bluff, kindly man who had been Dean of the University of Southern California Medical School, came on board. Dr. Egeberg was committed to the same forward views as John Knowles; he knew very well that the American health nonsystem needed reorganization, that millions of Americans were foregoing needed care for lack of cash or facilities, and that many more were being bled for health care during the period—sickness—when they could least afford it.

Dr. Egeberg started out valiantly. But H.E.W. was not U.S.C., and the job was not his cup of tea. Getting anything done in Washington requires sharp expertise, intelligence, determination, political savvy, and power. "Egeberg is a very fine individual," said a co-worker not long after he came into office. "But he doesn't know how to get hold of the knives, and he doesn't even know the people around him are cutting him up."

Still lacking a health plan or leader, the White House at last began to perceive that national health, and particularly national health insurance, could become a burning issue during or before the 1972 election campaign. In the description of an official close to the action, "In September there was a decision that this was a year of health. So a hysterical exercise began." There were no alternative health plans on the shelf, as there should have been with any decent kind of health planning.

The result—as formally presented in February by H.E.W. Undersecretary John G. Veneman (ex-California legislative leader), Deputy Undersecretary Robert Patricelli (a lawyer), and Assistant Secretary for Planning and Evaluation Lewis Butler (a lawyer)—was a "National Health Standards Act" and "National Health Partnership: a comprehensive Health Policy for the '70s." (Veneman did have experience in legislative direction of Medicare-Medicaid programs.)

The new program commendably in-

cluded proposals to increase health manpower; to assign some of it to urban and rural medical disaster areas; and to encourage doctors, hospitals, and patients to join in "Health Maintenance Organizations"—in effect, prepaid group practice complexes like the highly successful Kaiser-Permanente plans. The "health standards act" was the insurance heart of the program: requiring businessmen and workers to contribute to a high minimum level of group insurance and covering most low-income families with private policies paid for entirely or in part by the government.

But—low-income single or married persons without children were left only with present welfare medicine or medicaid (an aid-to-the-poor plan which is working badly or not at all in most states). The low-income "Family Health Insurance Plan"—linked to the administration's proposed "Family Assistance Program" (the guaranteed minimum income), therefore dubbed F.H.I.P., Son of F.A.P.—would provide only 30 days' hospital care per illness. Part-time employees would be excluded from the group insurance plan, and—as conservative Republican Senator Peter Dominick of Colorado quickly pointed out—this would encourage the small employer to switch from full- to part-time help. With required co-payments, Senator Kennedy was quickly able to point out, "a $7,000-a-year worker could end up paying about $1,800, or 25 per cent of his salary, for a $5,000 illness."

Also, citizens over 65 would be left under Medicare, which is currently paying much less than half of their health costs and is suffering a steady whittling down, especially for long-term nursing home benefits. A $5.30-a-month charge for Medicare doctor-bill coverage would be dropped, but recipients would have to pay instead for a share of hospitalization on the 13th day instead of the 61st.

In other words, the old would now be charged less when they're well but more when they're sick. No wonder some reporters wondered whether Senator Kennedy had somehow managed to secretly write the Nixon plan.

A Short Lesson in Insurance Finance

The American Medical Association and the American insurance industry have offered alternate plans which would actually go further than the administration's in many aspects. Both these and the administration plan would rely on federal subsidies in one form or other to extend private (Blue Cross, Blue Shield and commercial) insurance. And this focused attention on this kind of insurance as it had never been focused before.

The February *Social Security Administration Bulletin* shows that operating expenses of commercial health insurers for group policies averaged 13 per cent of premium income in 1969. ("Expenses" include agents' fees, promotion, and any profits.) Expenses of Blue Cross plans (nonprofit) averaged 6 per cent. Direct Social Security Administration expenses in operating Medicare ran between 2 and 3 per cent (though this does not include rent and many other hidden governmental expenses).

Despite their high expenses, the commercial insurers managed to pay back policyholders (or their medical providers) 94.1 per cent of all premiums collected, compared with 97.8 per cent by Blue Cross and 91.1 per cent by the somewhat less efficient Blue Shield.

"But the commercial insurers lost $15 million doing this in 1969," pointed out Dr. Rashi Fein, Harvard medical economist, and if Congress adopts the President's plan, "we will not be taking over a thriving industry."

Leading health insurers—the big companies like Aetna and Prudential—soon replied that for their larger groups, their administrative expenses were only 4½ per cent or so, comparing favorably with Blue Cross or real Social Security costs. If given a government mandate for national coverage, they argued, they could do just as well.

The administration, what is more, has pledged to "regulate" the health insurance industry to limit its charges. But this is another part of the promised package that has not been fully presented. Examination of the 1969 figures of the companies themselves shows that overall group coverage "expenses" of even the largest, most efficient firms (like Aetna, Equitable, Metropolitan Life) ran 9 and 10 per cent. Expenses of a myriad of smaller companies ran as high as 26 or 50 or even nearly 100 per cent in an appalling number of cases. Bankers Multiple Life Insurance Co. of Chicago, an advertiser of "Medicare supplemental protection" in the *Washington Post* and *Star* on Sunday, February 28, "earned" $5,270,399 in premiums in 1969 but paid out (in what the insurance industry terms its "losses") only $2,248,273. The rest was "expenses."

Wanted: a Direction and a Plan

It is clear that federal regulation of the health insurance industry will have to mean putting a large share of it out of the health insurance business, if costs are not to be astronomical. Will the Nixon administration bite this bitter bullet? So far we don't know.

This is partly because the Kennedy Health Subcommittee hearings to date have been more an adversary procedure —between the Massachusetts senator and his administration, A.M.A., and private health insurance foes—than a dispassionate examination of the American health system. This is our political way, it might be argued. Kennedy must build a public groundswell for his far-reaching plan or see it written out of existence when a conservative Representative Wilbur Mills and his House Ways and Means Committee get around to writing their own health insurance plan.

In the meantime, it seems, there will be mainly recrimination and politically colored debate, as the country moves toward what every health-insuring nation so far has found to be an increasingly expensive, if necessary, social burden.

Is there any alternate way? In Great Britain during World War II, Conservatives and Labor and the British Medical Association agreed in principal that a national health plan was needed, as part of a broad social insurance system, and the famed "Beveridge Commission" made detailed plans. The plans were not unanimously loved when completed; they included a system of health centers (like the Nixon "health maintenance organizations") which financially pressed Britain has never really established. But at least there was an expertly drawn plan which could then be properly subjected to the political process.

We are weary to death in this country of commissions as substitutes for action. But in this case, where there is agreement among Republicans and Democrats that health reform and health insurance are desperately needed, why couldn't Congress: (1) agree by a resolution on goals (health care and optimum coverage for all); (2) name a commission of experts and consumer and political persons to propose a step-by-step plan, or alternate plans, if there were no unanimity; (3) then examine and act on these, with full play at this point of the political and public process?

Victor Cohn, who directs the science writing staff of the Washington Post, *writes regularly for* Technology Review.

The "Grand Tour" concept provides for three planets to be viewed from a single spacecraft starting in 1976 and 1977, at high cost and with great public visibility. Does it squeeze out smaller, more certain missions with higher scientific priorities?

Toward a Wider Vision of Earth

Between now and 1988, while America strives for a better social and ecological balance and poor nations struggle to avoid starvation, scientists on Earth should be gaining close-up views of all the other planets and many of their moons. These trips to space will vastly enlarge man's vision of his place in the order of nature—absurd, alone, grander or meaner than before. They should have fairly immediate impacts on the sciences of the earth at a time when man as a species begins to have a detectable impact on the atmosphere and oceans. But their planning raises questions of priorities in which scientific goals and political reality seem to work against each other.

For those who enjoy television views of other worlds, there should be close-up orbital pictures of Mars every day, from as near as 500 miles, starting this Thanksgiving; a flyby view of Venus from as near as 3,100 miles around February 5, 1974, and of Mercury from as near as 625 miles around March 30, 1974, and again around September 22 of that year. All this is to be performed by U.S. Mariners.

In 1973-75, two U.S. Pioneer craft are to come about 100,000 miles from the giant planet Jupiter, taking crude photoscans, measuring the atmosphere's composition and temperature, and probing the strength of the Jovian magnetic field. The first of these Pioneers will then whirl out through the solar system, transmitting data about the sun's waning influence to a distance of about 1.8 billion miles. The other will sail above the plane of the ecliptic, to which all planets more or less adhere, and spin back toward the sun, passing millions of miles over the north poles of several planets.

If even one of the expensive pair of soft-landing American Viking craft successfully establishes itself on Mars, Earth should be getting pictures and weather reports—and chemical hints of anything now or once alive from that planet—starting perhaps on July 4, 1976.

Four American "Grand Tour" craft, now endowed with the businesslike name of Navigator, are to take off in 1976, 1977, and 1979 to take advantage of a line-up of the tenuous, giant outer planets that only occurs once in every 175 years. The Navigators will approach Jupiter about a year and a half after leaving Earth. They will be close enough to Jupiter for perhaps 50 days to take pictures of the planet of better resolution than can be obtained by telescopes on earth. During this close approach the Navigators will also be able to focus in succession on several of the 12 Jovian moons.

After the Jovian encounter, during which the Navigators pick up speed from Jupiter's gravity, the 1976 and 1977 craft will push out to Saturn and Pluto and the pair of 1979 craft will sail to Uranus and Neptune. Because of the immense length of the pathways these planets follow, opportunities for even a two-planet mission of this kind are rare. The next chance for a Jupiter-Uranus shot comes around 1990. For a Jupiter-Saturn mission, scientists would have to wait until 2000.

The plans of the Soviet Union for space exploration during this same period are, of course, unknown. The Russians have recently been leaving Mars to the U.S., concentrating instead on probing the atmosphere of Venus. (The latest probe, Venera 7, survived half an hour on the surface and reported a temperature of 900°F.) No one can say at this writing whether the Russians will attempt to compete with the American plans to put two Mariners into orbit around Mars this fall. The two craft must take off between May 5 and June 3 to take advantage of the fact that 1971 is one of the years when Mars comes closest to Earth. Such close-close approaches—only 35 million miles—occur only once every 15 to 17 years.

The May launch opportunity is open to the Russians, and it is far from inconceivable that they plan to send a Marsokhod tractor equipped with two TV-camera eyes to roam around on Martian surface. (In the meantime the two American craft in 12- and 20.5-hour orbits would be mapping with resolutions down to one-tenth of a kilometer.)

This outline of definite American plans for space exploration encompassing the other eight planets and many of the 32 moons of the solar system neglects proposals for other types of exploration, and it fails to encompass the considerable debate about the scientific priorities, which is not receiving anything like adequate public attention.

There are plans, for example, for a Planetary Explorer craft, a sort of solar system "bus" that could carry rigorously simplified probes, orbiters, and landers to Venus every 21 months or so (and which could also do interesting things on Mars, and even on the moon in the hiatus in manned exploration which is now planned for after December, 1972).

Those plans have particular appeal to the National Aeronautics and Space Administration's Goddard Space Flight Center, which designed the Planetary Explorers a few years ago but never received money to press on, and to Richard M. Goody of Harvard, who headed a panel of the National Academy of Sciences' Space Science Board last June which found the Planetary Explorer concept ideal for getting the U.S. into the Venus exploration business.

N.A.S.A.'s Ames Research Center at Moffett Field, Calif., has done a lot of thinking and talking about upgrading its Pioneer craft—the ones that take off for Jupiter in February or March, 1972, and in April, 1973—for such tasks as orbiting Jupiter or carrying out the Grand Tour less expensively than the Navigator series could. The idea is that the Pioneers, which are designed as pathfinders for the Grand Tour, might turn out to have a better chance at reliability for 10 or 15 years—if they were loaded with redundant parts—than the Navigators.

Naturally, this idea has little appeal to the Jet Propulsion Laboratory, which has responsibility for the $700 million Grand Tour spacecraft series and which has spent years developing the so-called Self-Test and Repair (STAR) computer for assessing damages and malfunctions on board and switching to alternate equipment swiftly. The STAR concept is that this light-weight computer takes the place of heavier redundant equipment

otherwise necessary. STAR will also improve reliability by giving Navigator the ability to fix most troubles by itself when it is sailing at enormous distances from home base. With many light-minutes between Navigator and its J.P.L. engineers on Earth, it could take too long for a trouble to be spotted and a reaction organized. The Navigators will take off on ten-year journeys with equipment that has not lived that long in near-Earth space. Hence the emphasis on the STAR computer and on fairly conventional, tested experiments.

Another Scientific Spectacular?

Scientists like Professor Goody are excited by the scientific opportunities of a Grand Tour mission, but they also think the space program should give much more attention to the merits of small, uncomplicated experiments which allow a greater frequency and offer lower cost of failure. This is because they want to look deeply at one planet as well as fly by all of them. Looking deeply usually implies looking frequently.

In this view, there is a question about whether the STAR computer really streamlines things all that much. Does STAR pay its way? A number of highly interested observers think everybody should have one more hard look at the alternatives for carrying out an expensive and risky—if scientifically sweeping—enterprise like the Grand Tour.

Donald G. Rea, Chief Scientist at J.P.L., finds that this proposal could jeopardize the whole project. The scientific steering group for the Grand Tour project first met around April 1, the first $30 million for Navigator is up for congressional approval this year, and a fairly clear idea of the types of experiments to be flown has already taken shape.

Basic changes at this stage would render the plan—with its 1976 deadline—almost impossible. Thus as things stand now, the U.S. space agency has decided to go ahead with the Navigator project and will bide its time about such plans as the $130 million proposal for a succession of probes, orbiters and possibly landers to Venus starting as early as 1975.

Although the Nixon administration's budget for the year beginning July 1 does carry a provision for studying the diversion of one of the Navigators to go into orbit around Jupiter rather than proceed further, NASA's current policies appear to be the exact reverse of what was recommended by the Space Science Board after an exhaustive study of priorities in Woods Hole, Mass., last summer.

The late appearance of the Space Science Board's detailed conclusions surely had the effect of hampering public debate on the important questions of the future of planetary exploration. Although N.A.S.A. officials heard a summary last August 15, the report was not published until early March. This was after N.A.S.A. already had disregarded key recommendations by cancelling two lunar landings and by choosing the Grand Tour to start earlier than the Venus shots. (To be fair, there are increasing signs that N.A.S.A. intends eventually to approve the Venus program; the Grand Tour was chosen because there was no time for delay and because President Nixon had specifically endorsed the concept.)

Even if the Space Science Board showed political naivete in going against a project with political glamor—while including a lot of glowing language about the attractiveness of the idea—its views deserve more of an airing than they received. The group that steered the priorities study, headed by Dr. Herbert Friedman of the Naval Research Laboratory, proposed that the Grand Tour would be possible only within a planetary exploration budget about 50 per cent higher than the $560 million of the current budget year. Venus probes and Jupiter orbiters were given highest priority within the current budget level. Dr. Friedman and his colleagues omitted the $800 million Viking program, already under way, out of their accounting; by doing so they made it clear that the $145 million increase in planetary exploration necessary to push Viking along doesn't really count.

"If the higher budget program is funded, including the Grand Tour, the Jupiter exploration missions would follow in the 1980's," the Friedman panel recommended. "We concluded, however, that a thorough study of Jupiter is, for the near future, the most rewarding objective among the outer planets and will contribute to the experience needed for successful missions to more distant planets at a later time." The Friedman panel also gave a higher priority to orbiting a 1.5-meter optical telescope in the mid-1970's; it is more attractive than the Grand Tour "because of (the telescope's) higher scientific promise." Although the study group recognized "the uniqueness of the natural opportunity and the importance of the planetary observations that could be accomplished," it was worried about the Grand Tour's huge cost squeezing out smaller missions which it thought had higher scientific priorities.

In recommending against the Grand Tour, the Space Science Board panel raised the linked issues of risk and scientific inflexibility. "We are concerned that the greater demand that the Grand Tour places on high advanced technology and its survivability carries greater risks, and that the entire program, including mission profiles and scientific strategy, is likely to be inflexibly determined before the lessons of the first flight can be applied to successive launches."

This language by the Friedman steering group was slightly chillier than that of a subordinate working group on planetary exploration, which recommended "that the exploration of the outer planets proceed at the highest level consonant with preserving (the) inner-planet program. This means the full Grand Tour mixture, if possible technically and fiscally."

The planetary working group, with Michael McElroy of Harvard as chairman, noted that if Viking produced "positive signals" of life on Mars, then follow-on Viking missions "would rise to the highest level of priority." But if the Viking program foundered because of high costs, N.A.S.A. should give high priority to relatively inexpensive atmosphere probes of the sort planned for Venus by the Goody group in June and largely endorsed by the Space Science Board study.

The need for exploring several planets to better understand Earth was stressed by the McElroy working group: "In many respects we are like linguists on an isolated island where only one language is spoken. We can construct general theories of language, but we have only one example to examine. . . ."

Victor K. McElheny, Science Editor of the Boston Globe, *writes regularly in this space for* Technology Review*—and frequently on subjects associated with the U.S. space program.*

The Puzzlements of an Experimental Species

Catharsis and Counterpoint

The Endless Crisis: America in the Seventies; A Confrontation of the World's Leading Social Scientists on the Problems, Impact and Global Role of the United States in the Next Decade.
Edited by François Duchêne
Simon and Schuster, New York, 1970,
310 pp., Clarion paperback, $2.75

Reviewed by
Sanford A. Lakoff
Professor of Political Science
University of Toronto

This volume is an edited version of the proceedings of a well-publicized conference held at Princeton in December, 1968. The title is, to say the least, puzzling. If words still mean anything, in this age of gobbledygook, Newspeak, and media as message, massage or *mensonge,* what exactly is an "endless crisis"? Whether a crisis is defined in medical, astrological, or figurative terms (as it is in my dictionary), it always means a decisive moment or turning point in a process. How, then, can a crisis be endless and still be a crisis? Anyone who imagines he will find an answer by consulting the text will be disappointed, since none of the participants, including the editor, ever so much as mentions the notion that we are led to believe must have pervaded the discussion.

The awkward subtitle can only add to the confusion. Some of the participants undoubtedly have a claim to be considered among the "the world's leading social scientists," especially if public recognition rather than academic reputation is the measure. John Kenneth Galbraith, Arthur Schlesinger, and Jean-Jacques Servan-Schreiber would then deserve their inclusion, even if the academic guilds might not wish to be represented by such popularizers. But by what logic is the designation stretched to apply to the playwright Lillian Hellman, the editor Norman Podhoretz, the politician Allard Lowenstein, the poet Pierre Emmanuel, the student activist Sam Brown, the black nationalist Roy Innis, the diplomat George Ball, and assorted other personages, all worthy of a hearing in their own right but surely miscast by the subtitle?

These difficulties could easily have been avoided by the selection of a more appropriate, if not more modest, set of titles. About the only virtue of the one we are offered is that it is at least a warning of what is to come. To be sure, in the record of a short (four-day) conference of ninety-odd pundits, nearly all of them prima donnas of the verbal arts, one should expect to stumble over a cliche here and there. But these proceedings, if the reader will pardon an attempt at a French pun, are a veritable *embarras de clichesse.*

Games Intellectuals Play

Anyone who examines the text of the book will be tempted to conclude that a more fitting title might have been something like *Games Intellectuals Play; with Instructive Illustrations of Hyperbole, Caricature, and Role Playing.* No one would be likely to conclude that anything very serious of an intellectual sort was accomplished at this conference, even though the participants included many very gifted people. The conference format seems to have brought out the least creative and least interesting qualities of mind in almost all of the conferees. No point is pursued in any depth or with any rigor; disputes are not brought to a conclusion but only terminated, in time for cocktails. A fresh thought, a newborn idea, apparently could not emerge or survive in the stale and unsupportive atmosphere.

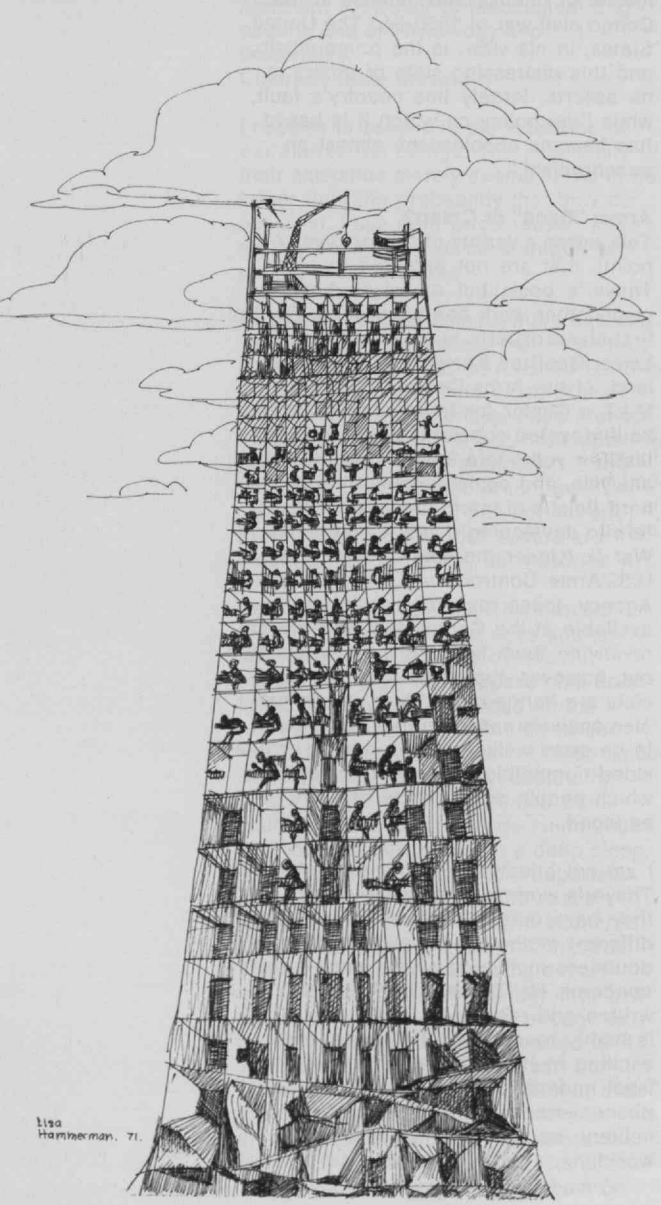
The most publicized event of the conference was yet another shootout at Generation Gap. True to form, there was George Kennan, otherwise known for his penetrating studies of diplomatic history, denouncing the U.S. student protest movement—in toto—as nothing more nor less than a reincarnation of the Russian student agitation that brought on the Bolshevik Revolution. Edward Shils, the normally provocative sociologist of ideas, agreed with Kennan, adding that "youth has been made into a false god." Ranged against them was a predictably self-righteous (and hairy) group of youthful outlaws, wearing the latest styles of alienation as only affluent Ivy Leaguers can, and professing to be shocked beyond mere tears by the frightful hypocrisy of their elders. Sam Brown answered the exaggerations of the spokesmen for the establishment by a counter-escalation of his own, charging that the "rational liberals" who had preceded him had given an example "of violence, of hysteria" far worse than the young were now capable of producing. In between the two camps, like a marshal trying to keep the peace, rode Stanley Hoffman, a political scientist who, in a long essay for *Daedalus,* has provided a superbly subtle study of university government. Here, however, all he managed to prove was that he was capable of straddling an issue, if not a horse. "Certainly," he is reported to have observed, "there is something grievously wrong about destroying the universities, but can one really assume that there is absolutely nothing in them that ought to be changed?"

No less predictably, there was a set piece on racism. Roy Innis got the scene underway by telling Mr. Charlie everything he presumably came to hear: how the only difference between southern white supremacists and northerners is that the southerners are "honest racists"; how integration is a "Mickey Mouse solution"; and how the only way out of the problem is for the whites to agree to a "new social contract" whereby blacks would form a separate national entity within the geography of the United States.

("We will then link up the identities of our Roxburys, Harlems, and Wattses into a nationlike structure which is unique in that we will be islands not in the sea, like Indonesia, but islands in land.")

An Indian Moslem with some hard practical experience of partition and a Venezuelan sociologist mindful of racial relations in Latin America then sought to persuade Mr. Innis that his scheme was rather impractical. John B. Oakes of the *New York Times* added that it was not only impractical but immoral as well, since it amounted to an advocacy of apartheid. It remained only for the Indonesian ambassador to the U.S., a Mr. Soedjatmoko, to suggest a higher Hegelian synthesis of the two dialectical opposites: "We should not be frightened by the rhetoric of black power" but should see it is a necessary corrective of white racism which would ultimately make integration "psychologically possible" for blacks.

". . . what exactly is an 'endless crisis'? Whether a crisis is defined in medical, astrological or figurative terms, it always means a decisive moment or turning point in a process. How, then, can a crisis be endless and still be a crisis?"



Through a Cartesian Glass Darkly
In the area of general socio-economic analysis, all hope for a useful exchange was lost because the participants failed to agree on common terms of discourse. Servan-Schreiber and Michel Crozier, a French sociologist of organizations, chose to look at America through a Cartesian glass darkly, contrasting what they saw as an "aggressive confidence in human reason" with the irrationality and "existential anguish" arising in its wake. Daniel Bell, the sociologist, and Zbigniew Brzezinski, the political scientist, concentrated on what they regarded as the changes that mark an epochal transformation of industrial society. Martin Peretz, a younger social theorist, derided their "crystal ball gazing" and instead sought to restate C. Wright Mills' indictment of the irresponsible power of corporate wealth. When pressed, however, he turned out to be unwilling to embrace a socialist solution, making it hard to see wherein he differed from those he criticized, except that he called for the sort of public-interest controls they thought had already begun to emerge. Bell and Brzezinski meanwhile staged their own play-within-the-play over the patent rights to their joint intellectual discovery, Bell pointing out that he coined the term "post-industrial society" a number of years back, Brzezinski, apparently reluctant to pay even symbolic license fees, plumping for his own trademark, "technetronic society." Names apart, the theories are not very different and neither is adequately expounded here.

The last section of the volume is occupied with a discussion of the role of the United States in the world. Andreas Papandreou, economist and exiled Greek politician, performed his well-known rendition of "Yankee Go Home" and Ambassador Ball obliged by doing the counterpoint. The duet of Brzezinski and Hoffmann offered a variation, "Yankee Go Home, But Selectively," and were joined by a chorus of Europeans who, however, could not agree among themselves on just where to allow the Americans to sing solo. The Asians and Latin Americans generally sang in harmony with the Americans, except that they were anxious to pick up the rhythm of development in their parts. The Czech refugees did their own number, which stopped the show and could have been called, "Yankee Go Home But Take Me With You." It must have been worth being there just to hear the former director of the State Bank of Czechoslovakia say that the U.S. was closer to the spirit of socialism than the Soviet Union.

And so it went. A great event in the history of ideas? Hardly. A glimpse of the future? Let's hope not. What it may well have been, in retrospect, was a badly needed catharsis, an outlet for the steam that had to escape somehow from the pressure cooker that was the America of the late '60's.

Inter Arma Silent Leges

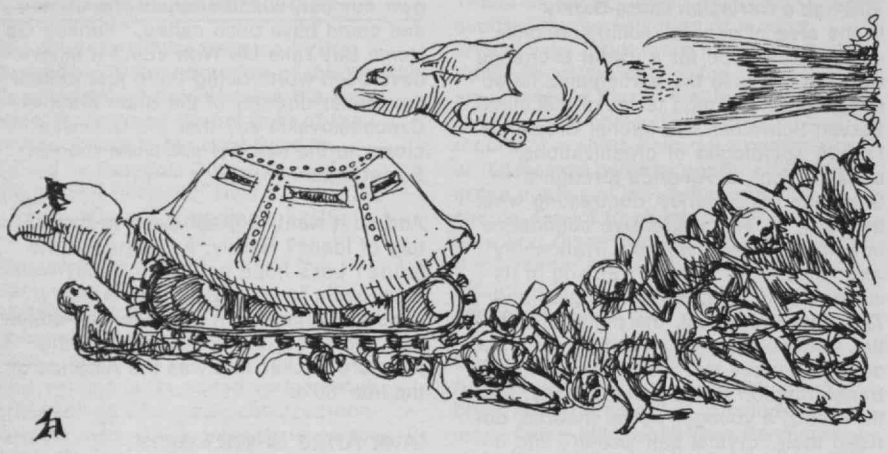
The War Business:
The International Trade in Armaments
George Thayer
New York, Avon paperback, 1969,
412 pp., $1.25

Reviewed by
Lincoln P. Bloomfield
Professor of Political Science, M.I.T., and Director, Arms Control Project, Center for International Studies

Extensively researched and popularly written, *The War Business* is an account of the history, the background, and the personalities involved in the sale of conventional arms both to developed and underdeveloped countries since World War II. (Though not about the U.S. domestic gun trade, one of the many tantalizing yarns the author spins has to do with Lee Harvey Oswald's mail-order acquisition of the imported Mannlicher-Carcano carbine which brought to an untimely and tragic end the life of the 32nd President of the United States.) The author is interested in exactly how the international arms trade works and, more to the point, to what extent the presence or acquisition of arms encourages the outbreak or the continuation of hostilities.

The book reads like a "whodunit" as Thayer briefly reviews the scarcely believable annals of the arms trade in the late nineteenth century. Figures like Sir Basil Zaharoff, who peddled arms the world over and became multimillion-

Is there an analogy between the fable of the Tortoise and the Hare and arms races? Contrary to the layman's expectations, in his book review below Lincoln Bloomfield, Professor of Political Science at M.I.T. and Director of the Center for International Studies' Arms Control Project, suggests that arms races are more akin to the Tortoise than the Hare. Does this make arms races less dangerous? Perhaps not, for the point of the fable is the formidable nature of slow but steady persistence—the Tortoise did, after all, win out in the end.



aires in the process, are bywords to those familiar with the muckraking literature of the early twentieth century, and of the later, fictionalized stories by Upton Sinclair (himself one of the earlier muckrakers).

Mr. Thayer reminds us that people tended to blame those so-called merchants of death for the outbreak of World War I. The Nye Committee, holding its famous—or infamous—inquiry from 1934 to 1936, deeply imprinted the notion of empires bought and sold, wars fought and won, and fortunes made and lost (chiefly made) through the nefarious sale of arms to the competing empires that finally destroyed one another in World War I.

Yet this also represents one of the main differences between the early period and the years since 1945. Mr. Thayer correctly ascribes much of the enormous traffic in armaments since World War II to the demands on the part of Third World countries, 117 of which depend on external aid for their military equipment. (On the other hand, recent research at M.I.T. on this subject points as well to the supply end of the equation—the pressures on the part of countries such as France to acquire a larger share of the arms business.)

A large portion of the book is devoted to a contemporary figure in the Zaharoff tradition, Mr. Samuel Cummings of Interarms, who, according to Mr. Thayer, controls 90 per cent of the arms trade. Anyone who has read Mr. Cummings' testimony to congressional committees will recognize the personal power of this clever and glib freebooter.

III Wind from the Pentagon

Zeroing in on the American Pentagon, Mr. Thayer then comes to what is certainly the central issue—the role of the governments of superpower countries. The author places particular emphasis on Mr. Henry Kuss who, until recently, in Thayer's words, "in truth heads an organization that is the dominating force in a worldwide jungle of bureaucrats and politicians who are far more ruthless and competitive than the likes of Cummings, munitions manipulators, gun runners, and mercenaries. In most respects," Thayer continues, "Kuss' very success at selling military weapons to foreign nations has been a major factor in the actual creation of that jungle." Mr. Thayer goes on to describe the important role of Britain, France, and other Western countries in competing for this lucrative armaments trade, but gives disappointingly little attention to the $7 billion of Soviet arms shipments, perhaps because few people really know the facts of that invariably clandestine enterprise.

An impassioned indictment of the arms trade as encouraging arms races and transforming political conflicts into wars concludes the author's thesis. He contends that "in the absence of arms and arms races, most of these postwar conflicts would have been channeled into diplomatic and political avenues for negotiation and solution." (This reviewer cannot, however, help recalling the extent to which beer bottles and wicker shields were often the chief means of offense and defense in the Congo civil war of 1960-64.) The United States, in his view, is the prime villain, and this distressing state of affairs is, he asserts, largely this country's fault, while "the policy on which it is based has become obsolescent, almost an anachronism."

Arms: "Race" or Creep?

This raises a variety of provocative points that are not explored in Mr. Thayer's book, but on which happily much other work has been done. Several first-class experts such as Amelia C. Leiss, Geoffrey Kemp, and John Hoagland, of the Arms Control Project at M.I.T.'s Center for International Studies, have devoted substantial energy in the last few years to a unique documentation, analysis, and computerization of the hard details of international arms transfers to developing countries since World War II. (Under the sponsorship of the U.S. Arms Control and Disarmament Agency, these research results are available at the Center, though I am not reviewing them here.) It must be pointed out, however, that what to some publicists are "arms races" turn out on precise analysis not to be that at all, but to be arms walks or arms creeps or one-sided competitions or even contests in which people do not know they are engaged.

I am not attempting to compare Mr. Thayer's work with this scholarship, since they have different purposes and use different methods—although both were doubtless motivated by the same broad concerns. Mr. Thayer's book is well written and represents journalism which is highly readable and at times even exciting in its portrayal of one of the least understood and most portentous phenomena of the modern political, military, economic, and commercial world.

"It does no harm to ask questions for which there are no answers," wrote Richard E. Dickerson, Professor of Physical Chemistry in a recent issue of Engineering and Science *(California Institute of Technology). Exploring the notion that as many as 50 million stars in our own galaxy "have planets comparable with Earth" and that "one estimate of the size of the universe predicts a total mass that would call for 10 billion such galaxies," then, suggests Dr. Dickerson, "life is far from being a unique or even a rare event." The cluster of galaxies (shown below) is in the Constellation of Hercules about 340 million miles from our own Galaxy (the spiral and lens-shaped objects are galaxies seen full-face and on edge.)*

Archeology, Astronauts and Salt

The Chariots of the Gods: Was God an Astronaut?
Erich von Daniken
New York, Bantam paperback, 1971, $1.25

Reviewed by
Terry J. Vander Werff
Assistant Professor of Mechanical Engineering and of Physiology and Biophysics,
Colorado State University

I happen to believe in the existence of extraterrestrial beings. The probability of their existence merely seems to me to be larger than the probability that they do not exist. I see no a priori reason why earthly beings should be a unique happening in the universe.

Erich von Daniken takes a more extreme view; he not only asserts that these beings do exist but that they visited earth in the past, leaving behind clues of their visits in the form of unexplained archeological anomalies. The book attempts "to provide proof of this assertion." Don't believe the book cover which says (English version): "He has not set out to prove anything." Book covers are meant to sell the book, not describe it.

Let's quote von Daniken's hypothesis: "Dim as yet undefinable ages ago an unknown space ship discovered our planet. The crew of the space ship soon found out that the earth had all the prerequisites for intelligent life to develop. Obviously, the 'man' of those times was no *homo sapiens,* but something rather different. The spacemen artificially fertilized some female members of this species, put them into a deep sleep, so ancient legends say, and departed. Thousands of years later the space travellers returned and found scattered specimens of the genus *homo sapiens.* They repeated their breeding experiment several times until finally they produced a creature intelligent enough to have the rules of society imparted to it. The people of that age were still barbaric. Because there was a danger that they might retrogress and mate with animals again, the space travellers destroyed the unsucessful specimens or took them with them to settle them on other continents. The first communities and the first skills came into being; rock faces and cave walls were painted, pottery was discovered and the first attempts at architecture made.

"These first men had tremendous respect for the space travellers. Because they came from somewhere absolutely unknown and then returned there again, they were the 'gods' to them. For some mysterious reason the 'gods' were interested in passing on their intelligence. They took care of the creatures they bred; they wanted to protect them from corruption and preserve them from evil. They wanted to ensure that their community developed constructively. They wiped out the freaks and saw to it that the remainder received the basic requirements for a society capable of development."

From this point on, any human experience or archeological discovery which might possibly pertain to Mr. von Daniken's thesis is brought in as concrete evidence of his theory's validity. The biblical references, for example, to "chariots of fire" and "angels" are introduced by the author as direct equivalents of "spaceships" and "astronauts."

Some of the evidence used to support the theory is predictable: the enormity and precision of the Egyptian Pyramids, the gigantic statues on Easter Island, the ruins of the Mayan empire. Two of the so-called proofs are of interest:

The first is the maps of Admiral Piri Reis of the Turkish Navy found in the early eighteenth century in the Topkapi Palace, Istanbul. The maps accurately reproduce not only the Mediterranean area, but also the coasts of North and South America and even the contours of Antarctica. Of particular interest on Reis's maps are the mountain ranges in the Antarctic which were not discovered until 1952 with the help of sonar equipment. Photographs taken from Apollo 8 directly above Cairo tend to confirm the accuracy of the Piri Reis maps.

The second "proof" is the strange markings on the Plain of Nazca in Peru which bear a remarkable resemblance to airport runways and parking bays. Nearby, above the Bay of Pisco, is a huge 820 foot figure on the cliffs pointing to the Plain of Naxca. Instead of a religious symbol, could this possibly be a direction indicator for a space visitor?

One further item of interest is the drawing on one of the walls inside the Mayan Temple of Inscriptions at Palenque, Mexico. With little imagination, the reader can see the similarity between the drawing and an astronaut reclined on his back in a space ship.

Whether your taste runs to such speculations or not, the book is an interesting compilation of archeological discoveries and—with a good, heavy sprinkling of salt—it is thought-provoking but not entirely convincing.

A recent New York City study cited as the five "most critical" problems facing that city's overburdened system of criminal justice: the breakdown in deterrance caused by the inability of the courts to process arrested suspects with fairness and dispatch; the spread of narcotics; the conditions in the city jails; the lack of city rehabilitation programs and the absence of wide spread program to prevent crime by young persons. But breakdown in the judicial system is not confined to any one city or state. The Superior Court of Massachusetts began 1969 with almost 53,000 cases on its dockets. After completing 2,000 trials, the year's end docket listed almost 55,000 cases awaiting trial.

Technology to Combat Crime?

Crime in America
by Ramsay Clark
New York, Simon and Schuster, 1970
346 pp., $6.95

Reviewed by
Deborah Shapley

Since World War II, technology has been spectacularly successful in meeting many national needs, especially defense and space exploration. But in others it has failed—including the urgent need to prevent and control crime.

◇ A policeman arrives on the scene of a reported bank robbery and sees two men running away. He orders them to stop but they don't. He can't hit them with his billy club. What can he do but shoot? Thousands of people not proven guilty of any crime have been killed because of our failure to provide nonlethal weapons for the police. After all, technically, it is a long way from the nightstick to the pistol.

◇ Our correctional system employs 125,000 people. Eighty per cent of them are guards and administrators; only 25,000 attempt to provide medical care, social counseling, job training, and postprison supervision to the 800,000 prisoners. Yet these are the only services which offer hope of helping a criminal stop repeating his crimes.

◇ In the last 25 years, the United States has gone to the moon, invented the Polaris submarine, and learned to fire missiles at Russia which will land within a radius of a few miles. But it has built only two new federal prisons.

Like many of the books coming out now by associates of consumer advocate Ralph Nader, *Crime in America*, by former U.S. Attorney General Ramsay Clark, is about the need to modernize a profession. The book names American society and character as the culprit responsible for our increase in crime: "we are cruelly afflicted with crime because we have failed to care for ourselves and our character," summarizes his thesis. But one need not agree with this view to read the book anyway and find it immensely useful as a layman's guide to the professions of law enforcement, justice, and corrections—and how they must modernize if the country is to be spared further disorders.

When *Crime in America* first appeared, it was hailed by liberal reviewers as a great humanitarian document—as *the* answer to hard-line law-and-order advocates like Attorney General John Mitchell and J. Edgar Hoover (who replied to Clark's views in the book by calling him a "jellyfish" in the press). But a phenomenon like crime becomes a basket of political hot potatoes only if those who make its control their daily concern have not agreed on how to proceed.

There should be an important role for technology and the social, behavioral, and management sciences in modernizing these professions, maintains Clark. Social scientists now working on counter-insurgency in Asia, architects now designing urban skyscrapers and suburban tract housing, engineers developing satellite communications systems—all should dip into Clark's book to see what *their* fields could do to help the ailing profession of law enforcement. They will find points like these:

◇ *Drugs.* Clark estimates that finding a cure for heroin addiction would run half the cost of building a nuclear submarine.

◇ *Statistics.* Today's crime statistics make the U.S. census look like a mathematician's dream. All statistics used are based only on reported crimes: *actual* crimes bear a varying and unknown relationship to reported crimes. In the ghetto, perhaps one-fifth of all crime is reported, while in a rich neighborhood every single theft (including some that possibly didn't even take place!) is reported so that residents can collect insurance. Teenage crime is increasing—but then so is the teenage population. How do you insert this information into the local, state, and F.B.I. figures?

◇ *Management and administration.* A city police department has thousands of employees and offers an impossibly wide range of services, from bicycle registration to rounding up narcotics rings. The level of organization required is very high—yet municipal departments often have "modernized" by simply adding more and more people to the same divisions. What about specializing part of the force to do specific tasks, like the 22-month experiment in New York City to train 18,000 patrolmen to calm down domestic disturbances?

◇ *Electronic communications.* The walkie-talkies used by police during urban riots were provided by the U.S. Army and originally developed for jungle use. But they don't work well in the urban jungle. Perfecting a communications system whereby the movement of every policeman on (and off) duty is shown on an electronic board, with an effective radio deployment system, is an elementary need in many cities.

◇ *Data Processing.* Automatic data retrieval could bring speed and uniformity by recalling pertinent briefs, decisions, and legal documents for judges. Automatic sound recording and transcribing equipment could eliminate the weeks of delay now caused by the traditional transcribing ceremonies of court stenographers.

We know very little is known about who the criminal is—under what conditions he tends to a violent act and when he doesn't. These are questions which, if given adequate, systematic study in the psychological, social, and behavioral areas, could help deter crime as well as rehabilitate the criminal.

To the (now, most likely, unemployed) professional and technologist who has adopted the idea that technology should aid the reordering of national priorities, Ramsay Clark puts a simple question:

"Is it not far more important for man to know what makes him capable of strangling another human, of cutting out hearts and dismembering bodies, of gang-raping a young girl, or pack-mugging and killing a dirty, grizzled old vagrant, than to know what is on the far side of the moon?

"Is the answer beyond the reach of a people who double their knowledge of the physical world in a decade?"

Here is what your friends will find in June:

How Clean a Car?
John B. Heywood, M.I.T.

"Emissions from new cars have already been substantially reduced through the federal control program, and by the late 1970's new cars will probably be close to the 1975-76 federal emission standards. . . . The responsibilities of owning a car in the 1970's and 1980's will clearly be more onerous and costly than they are now, if effective control systems are to be maintained. But if it all does work out, emissions from automobiles by 1980 will be less than one-fifth of what they are today. Even so, the smog may never totally vanish from Los Angeles."

Technology and the Future Growth of International Organizations
Eugene B. Skolnikoff, M.I.T.

". . . Whatever the political developments of the next two decades, technologically related developments that are in some sense 'inevitable' will pose major new international requirements. . . . Clearly, as a minimum, a substantial amount of extremely difficult institution-building and institution modification will be required. . . . Whether such 'evolution' will be enough, or whether we will need a 'revolution' in the existing international order, is a controversial judgment . . ."

Biological Control and a Remodeled Pest Control Technology
Carl B. Huffaker, University of California

"Some changes must be effected before pest control methodology can be put aright. . . . We need to establish what pests are real ones and at what densities. . . . We need (to make) maximum use of cultural and supportive measures of control. . . . We need to learn the full potential of our resident natural enemies. . . . We need to look at use of pesticides as a measure to supplement selective ecological methods. . . . We need much new research to develop . . . principles of pest population limitation. . . . We need to reshape public attitudes about acceptance of produce that may bear blemishes. . . . We need to develop a field working corps of pest control ecologists to replace the pesticide salesmen. . . ."

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". . . We need more warning than the miner's canary could provide when we are concerned with a global problem, for we cannot leave the world, and we cannot afford to be made to leave any substantial part of it, even temporarily. We must meet a global threat by forestalling it." (Photo: Boston on September 24, 1969; Aerial Photos of New England from Massachusetts Audubon Society)

Is man so changing his planet's environment as to affect his prospects for survival? As it turns out, he knows surprisingly little about the answer

George D. Robinson
Center for the Environment and Man, Inc.

Global Environmental Monitoring

When the miner's canary died it was time to get out of the mine. This was a primitive form of environmental monitoring—a concept not at all synonymous with measurement; indeed it need not involve quantitative measurement. The essential feature of monitoring is that it should provide timely advice or warning of some eventuality.

The current concern with man's impact on his environment brings increasing talk of environmental monitoring. In this article we shall be concerned with monitoring those of man's environmental effects which may have a worldwide impact. From this standpoint global environmental monitoring does not necessarily entail the collection of observations on a worldwide scale; it is the provision of advice or warning on phenomena with a worldwide impact, just as the miner's canary provided warning within the small environment of the mine. It is essential that the advice or warning should come in time for effective remedial action to be taken. We need more warning than the miner's canary could provide when we are concerned with a global problem, for we cannot leave the world, and we cannot afford to be made to leave any substantial part of it, even temporarily. We must meet a global threat by forestalling it.

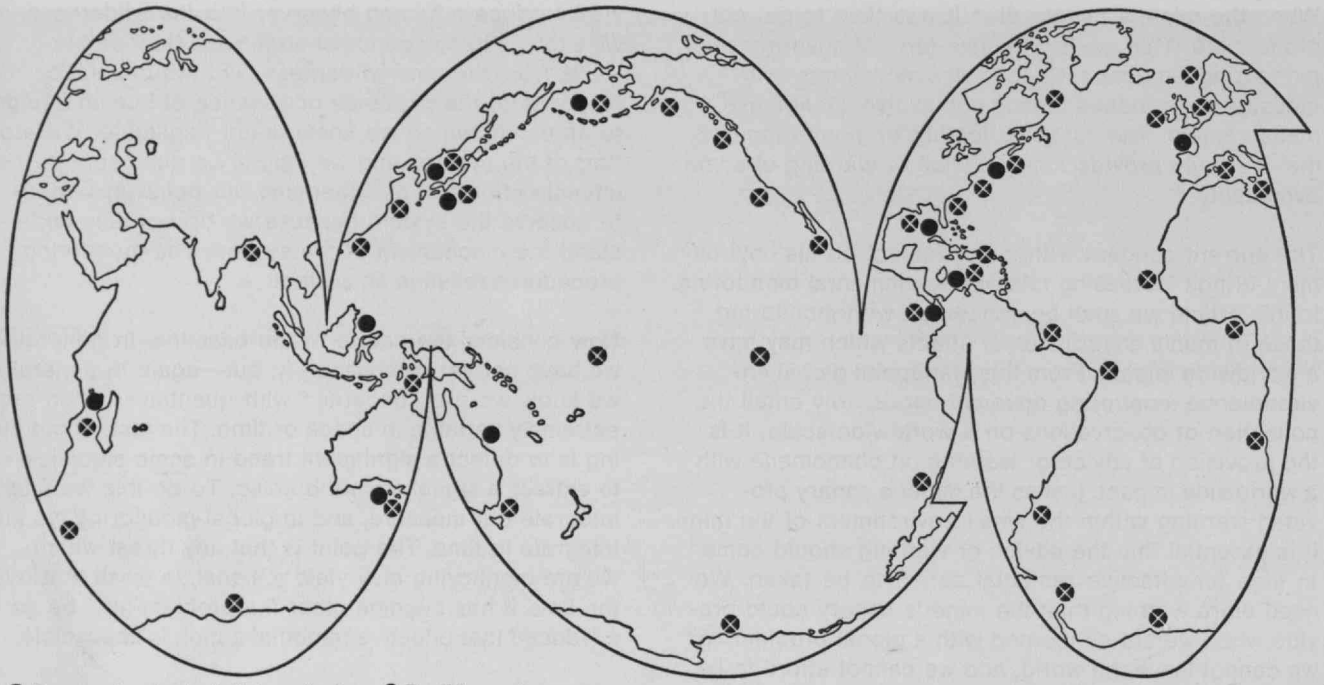
It follows that there are two prerequisites for effective global monitoring: to recognize that a change is occurring we must know the initial undisturbed state or "baseline," and to implement remedial measures we must understand the mechanism of the change. We must also know how to make the relevant measurements, and thus to set an appropriate alarm. Clearly we have no a priori assurance that useful monitoring of any specific global change is practicable. The nature of the baseline, the nature of the mechanism of change, or the nature of the process of observation might individually or collectively inhibit it.

Consider, for example, the nature of the observing process. It does not leave undisturbed that which is observed. The reaction may be negligible; for example, the solar energy falling on a surface within the atmosphere depends to some extent on the reflecting properties of the surface itself, and a measuring device modifies these because it includes an absorber, but the device can be made very small and the modification quite negligible. On the other hand, if we are observing the population of living things in a specified region, we introduce a human observer into the wilderness, or we exclude hunters and fishermen and their edible waste from the near-wilderness, and the population responds to the presence or absence of human beings to an extent which we know is not negligible. We are part of the system, and we cannot be quite sure of the ultimate effects of our changing our behavior pattern to observe the system because we do not fully understand the mechanism of the system. The monitoring procedures result in an artifact.

Now consider the nature of the baseline. In general, we have not yet established it; but—again in general—we know we are concerned with quantities which are extremely variable in space or time. The task of monitoring is to detect a significant trend in some statistic—to extract a signal from the noise. To do this we must integrate our measure, and in global monitoring we must integrate in time. The point is that any threat which we are monitoring may yield a signal so weak that by the time it has become clear the problem may be so far advanced that effective remedial action is impossible.

To take a specific example, it has been suggested that man-made particles in the atmosphere are increasing the reflection of sunlight from the planet to space—the global albedo. It has also been suggested that a permanent increase of a few per cent in global albedo would return the world to an ice-age climatic regime. Neither of these statements has been confirmed, but either or both *may* be true. When we measure local albedo—the fraction of incident sunlight reflected from a limited area of the planet, surface and overlying atmosphere—we find it extremely variable. We have not yet measured global albedo; but this could possibly be done with tolerable precision using modern satellite technology. We do not know the variance of the annual mean of global albedo, but we know it could be considerable; a fluctuation of 0.01 would, for example, imply a fluctuation of only about 0.2° K. in the annual mean temperature of the mixed layer of the ocean, and we do not know this statistic with this precision. We do not know how long we might have to integrate to detect a trend; if such a finding could be made at all, it would depend on precise measurement carried out over many years. If at the end of these many years we found an increase in albedo, we would have clear indication of the need to decrease the quantity of particles we were putting into the atmosphere. This would not be

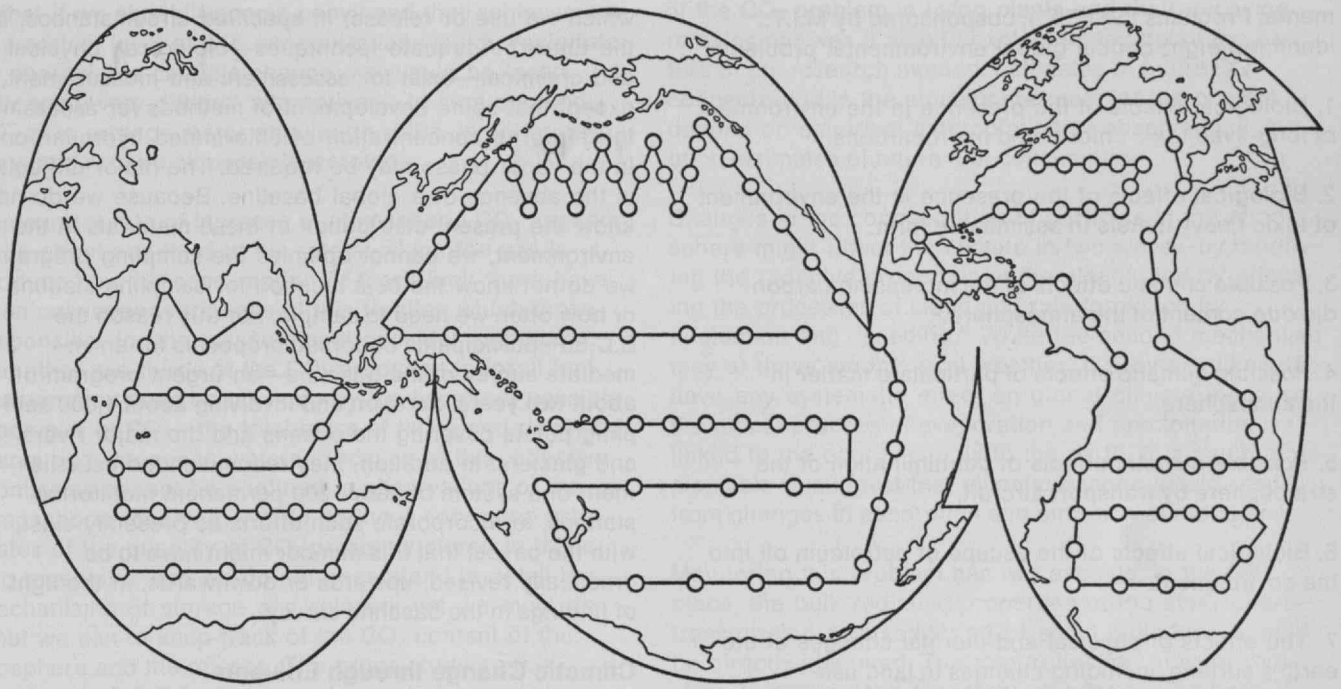
The maps show the locations of sampling stations proposed for baseline measurements of the amounts of man-made pollutants in the marine biosphere. Sampling stations for fish, mollusks, and crustacea are proposed at the outflows of major rivers and at the sites of down- and up-wellings of water; mid-ocean concentrations of these organisms are insufficient for efficient collection. But net-plankton and flying fish samples are proposed for the network of oceanic stations shown at the right. (Figures: Man's Global Impact on the Environment*)*



simple; agriculture as well as manufacture is involved, and rapid action would be economically and socially disturbing—perhaps prohibitively so—in a world preserving some elements of individual freedom. There might not be sufficient time to change our habits in a more systematic and less disturbing way. We would have failed in the task of monitoring.

We have examined a crude and much oversimplified example from the field of climatic monitoring. A slightly more sophisticated approach discloses indications that climatic monitoring useful in the sense of providing timely advice may in fact not be possible. Climatic statistics are, in general, not stationary; there is no clear distinction between signal and noise, and integration cannot make one. The mean annual global albedo may be such a statistic. Historical and geological records confirm the statistics deduced from instrumental records. Some 800 years ago there was a pastoral community in Greenland, and no one has suggested that man-made pollution caused the change of climate which destroyed it. Mathematical models of climate are systems of nonlinear equations in which minutely different initial and boundary conditions may yield radically different sets of solutions. Ecosystems and their mathematical abstractions appear to be at least equally complex. We may indeed discover that ecosystems cannot be monitored usefully—that is, in a way which not only records change but suggests and allows remedial action. It is, of course, always useful to know what has happened, and we have a duty to our successors to leave the best record we can; but documentation is not necessarily monitoring, and the natural historian may find our record more useful than the social engineer.

The problems of technique which arise in connection with global monitoring appear to be less intractable than these questions of principle. They are concerned with sensitivity, coverage, and precision. Anticipating a discussion of specific problems, we may say that sufficiently sensitive methods of measurement are in general available, although we may have overlooked some problems simply because the methods of observation which would disclose them are lacking. We might, for example, not be aware of the global spread of chlorinated hydrocarbons without the extreme sensitivity of chromatographic analysis. We would, of course, have noticed



the decline in numbers of certain species and described the symptoms of the disease responsible, but we might not have identified its cause.

Global monitoring implies global coverage, but we shall see that global coverage of some problems can be secured by observations in a very few localities, whereas in others very many locations must be occupied. Economy of effort is one essential of monitoring, not only because of the ever present need to conserve resources but because it is easier to maintain adequate standards of recording and interpretation if the volume of work (often repetitive and unexciting) is limited.

The value of artificial earth satellites in problems which call for continuous global surveillance has been very clearly demonstrated by the series of meteorological satellites which have continuously mapped the cloud distribution of the globe for several years and which are just beginning to record the temperature of the entire atmosphere. If a truly global coverage of observations is required, and if the observation can be made from a satellite, it is already clearly demonstrated that the satellite is the method of choice; there is little doubt that these vehicles will be increasingly used in global monitoring. However, precision must not be sacrificed to coverage. The global problems connected with possible climatic change are such that measurements of very high precision are required, and it is not yet clear that observations of the required standard can be made from satellites. Indeed, "absolute" methods of measurement of carbon dioxide concentration and of solar radiation, for example, suitable for use in the field —much less in satellites—have not yet been devised. Problems of intercomparison of relative measurements therefore arise, and particularly the difficulty of maintaining stable standards over long periods of time. These problems are not trivial; less than 20 years ago the radiation standards in use in some of the world's major standardizing laboratories differed by several per cent. There is a strong case for central international control of methods and standards of monitoring.

Critical Global Environmental Problems

If we can overcome these technical problems, what should we in fact be attempting to monitor? We turn now from general considerations to the problems of immediate concern. The 1970 Study of Critical Environ-

mental Problems (S.C.E.P.), cosponsored by M.I.T., identified eight critical global environmental problems:

1. Biological effects of the presence in the environment of long-lived toxic chlorinated hydrocarbons.

2. Biological effects of the presence in the environment of toxic heavy metals in assimilable form.

3. Possible climatic effects of the increasing carbon dioxide content of the atmosphere.

4. Possible climatic effects of particulate matter in the atmosphere.

5. Possible climatic effects of contamination of the stratosphere by transport aircraft.

6. Biological effects of the escape of petroleum oil into the environment.

7. The effects of physical and thermal changes at the earth's surface, including changes in land use.

8. Biological effects of the escape of nutrients into the environment.

This was not consciously a listing in order of importance, but there was a general feeling that the most immediate global threat comes from the first two items —the use or escape of persistent and mobile poisons— and that the fifth—the supersonic transport—calls for immediate monitoring action because its impact cannot be predicted with confidence, the necessary baseline is not well established, and the environmental challenge is imminent. The eight problems fall into three groups, which in their different ways illustrate all the difficulties of global monitoring.

The chlorinated hydrocarbons and the toxic heavy metals can be considered together. Monitoring should provide records of their production, use, and escape into the environment; of their concentration in the soil, the air, the elements of the hydrologic cycle (precipitation, lakes, rivers, and oceans), and living things; and of their effects on life. Monitoring should aim to answer these questions: What has happened to the material which we have used in the environment or allowed to escape into it, and what will happen to the material which we use or release, in specified circumstances, in the future? Adequate techniques—biological, physical, and chemical—exist for assessment and measurement, except that some development of methods for assessing the airborne concentration of chlorinated hydrocarbons in the vapor phase may be required. The major difficulty is the absence of a global baseline. Because we do not know the present distribution of these materials in the environment, we cannot optimize the sampling program; we do not know the best location for sampling stations or how often we need to sample. For this reason the S.C.E.P. participants endorsed proposals for an immediate survey of the baseline—an urgent program of about two years' duration and involving about 1,000 sampling points covering the oceans and the major rivers and glaciers. In addition, they recommended establishment of a system of about 200 permanent monitoring stations, to incorporate such efforts as presently exist, with the caveat that this number might have to be drastically revised, upwards or downwards, in the light of findings in the baseline survey.

Climatic Change through Effluents

The problems connected with climate change—third, fourth, and fifth on the S.C.E.P. list—are conveniently considered together since they have in common the difficulties created by the natural variability of climate and the nonstationary character of climatic statistics. In technical detail, however, they pose very different types of questions.

It now seems well established that a global increase in the CO_2 content of the atmosphere is taking place, though we must not overlook the fact that the entire body of reliable evidence can be condensed into a single presentation (*see pages 24 and 25),* and some responsible scientists still remain unconvinced by this evidence. The essence of the *monitoring* problem connected with this increase is to secure prediction, as far in advance as possible but certainly on a time-scale of tens of years, of the future atmospheric CO_2 content.

The long lead-time is necessary for two reasons. The first is that we are still far from having solved the associated scientific problem—will a change in atmospheric CO_2 content change the climate, and if so will the change be gradual or a rapid readjustment to a new equilibrium?—and we must continually consider the priority to be attached to efforts to solve it. The second

is that if we should become convinced that achievement of a certain level of CO_2 concentration would precipitate an appreciable climatic change, we would be faced with some very difficult alternatives—to stop emitting CO_2 or to arrange major population shifts. In either case we would require all possible warning.

The current rate of increase of atmospheric CO_2 appears to be about one-third of the rate at which the gas is produced by the consumption of fossil fuel; there have been only minor variations of this fraction which those responsible for the measurement consider significant. The other two-thirds of the CO_2 produced in fossil fuel consumption must be taken up by the two other possible reservoirs of CO_2—the total mass of living and decaying plants and the ocean waters. Because of this, effective monitoring cannot be confined to observations of the atmospheric reservoir. We do not have very good estimates of the quantity of CO_2 presently stored in these two reservoirs, and we do not understand in detail the mechanisms of storage and release; yet we must do what we can to keep track of the CO_2 content of the biosphere and the oceans. The group studying this problem at S.C.E.P., for example, made four recommendations:

1. Continuing attention to improving our estimates of our present and future consumption of fossil fuel.

2. Similar attention to changes in the mass of living matter and its decay products.

3. Continuous measurement and study of the carbon dioxide content of the atmosphere in a few areas remote from known sources—specifically, four stations and some airplane flights. The existing record at Mauna Loa Observatory, which is remarkable for both its accuracy and duration, should be continued indefinitely.

4. Continuing systematic study of the partition of carbon dioxide between the atmosphere and the oceans and biomass.

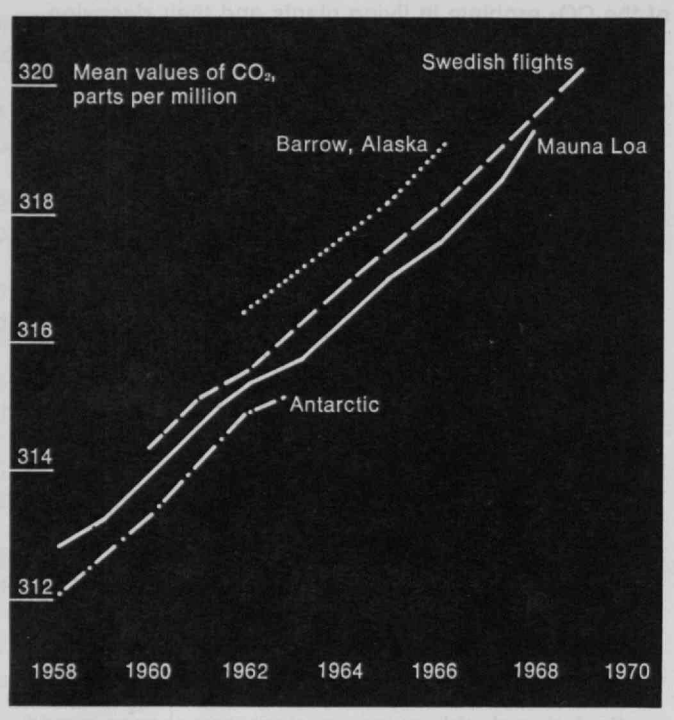
Specific suggestions concerning the nature and frequency of the ocean observations were included in the recommendations, and some guidance was given on the nature of the required research on the mechanisms of CO_2 partition between atmosphere and oceans. But the group was able to say very little about the significance of the CO_2 problem in living plants and their decaying remains nor was it able to explain in any detail the nature of the research needed. Estimates of future CO_2 concentration in the atmosphere must for the present depend on empirical extrapolation of observations and upon estimates of future fuel consumption.

Changes in the concentration of particles in the atmosphere might affect the climate in two ways—by modifying the radiative properties of the planet, and by affecting the processes of cloud and rain formation by nucleation and "seeding." While the second mechanism may at times modify local weather, it seems unlikely to have any systematic effect on global climate, because the global process of evaporation and precipitation is linked to the energy supply to the earth. It is much more plausible to suggest that climatic change would result from changes in absorption and emission of radiation.

Monitoring this problem has two aspects. In the first place, the bulk radiative properties of the atmosphere—transmission and scattering of solar radiation—should be directly observed. The total reflection of solar radiation to space—the planetary albedo—would be a particularly valuable measure, since any change would immediately change the mean temperature of the planet (though not necessarily the surface air temperature). In the second place, the particle load of the atmosphere should be observed directly by counting, sizing, and determining the chemical nature of representative collections of particles.

Measurement of the planetary albedo implies some form of extraterrestrial observation; it could conceivably be done from an artificial earth satellite. Since the atmospheric particles have, in general, a short residence time, their concentration is very variable in space and time; hence all suggested monitoring systems require local measurements. There are further complications. Most of the existing particle load is of natural origin, and many of the particles are formed in the atmosphere by chemical reactions between trace gases of both natural and human origin. We may take as an example the atmospheric chemistry of sulphur compounds. Sulphuric acid or ammonium sulphate constitute a ubiquitous class of atmospheric particles. These particles are almost certainly produced by oxidation of H_2S—which is predominantly of natural origin with a minor man-made contribution—and of SO_2 of volcanic

Systematic, accurate observations of atmospheric CO_2 content began during the International Geophysical Year in 1958. Data accumulated since then suggest that the content of carbon dioxide in the atmosphere has been increasing throughout the world at about 0.2 per cent per year—0.7 p.p.m. out of 320 p.p.m. (Chart: Man's Impact on the Global Environment)



and industrial origin. The ammonium ion comes from ammonia of predominantly biological origin. The concentration of these three and other trace gases is variable in space and time to an extent which is not yet fully known. Their mean lifetime in the atmosphere is in doubt; estimates of the half-life of the SO_2 in industrial emissions vary from tens-of-minutes to a few days, and all may well be true in the circumstances in which they were made.

For these reasons we cannot yet be sure how many observing stations will be required to monitor the particle load of the atmosphere in a way which will allow us to determine the origin of any change we may observe in the numbers, nature, or distribution of particles or in the associated optical properties of the atmosphere. The baseline information is again insufficient. The S.C.E.P. recommendations were:

1. Extending and improving the precision of measurements of the transmission of solar radiation which are already being made. (Simple photometry of the sun's disc with the Volz photometer is organized by the U.S. Air Pollution Control Office; measurements of total and diffuse solar radiation at the earth's surface are made by many meteorological services.)

2. Beginning measurements by lidar (optical radar) methods of the vertical distribution of particles in the atmosphere.

3. A study of the scientific and economic feasibility of initiating satellite measurements of the albedo of the whole earth capable of detecting trends of the order of 1 per cent in ten years.

4. A continuing survey, with ground and aircraft sampling, of atmospheric particles and of those trace gases which form particles by chemical reactions in the atmosphere. For relatively long-lived constituents, the survey should be based on about 10 fixed stations, for short-lived constituents about 100.

(These numbers are estimates which should be refined after a few years' experience. Here and elsewhere a requirement for efficient monitoring is the use of the minimum essential data-gathering capacity. The recommended survey might include 100 stations and stratospheric flights for studying sulfate and nitrate particles; 100 stations and tropospheric flights for measuring gaseous hydrocarbons; and measurements at 100 stations each of nitric oxide and nitrogen dioxide, hydrogen sulfide and sulfur dioxide, ammonia, and ozone.)

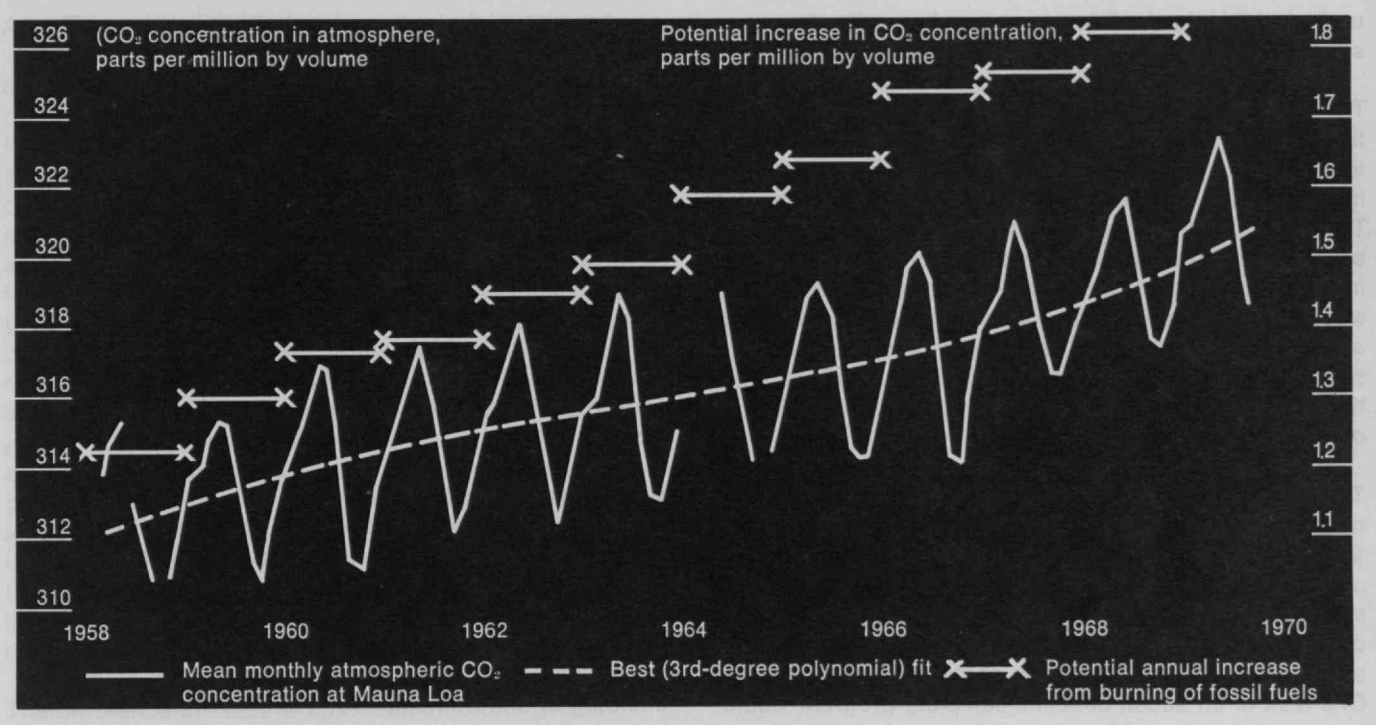
Supersonic Aircraft Emissions

The contamination of the stratosphere by aircraft emissions is a special aspect of the atmospheric particle problem. The supersonic transport aircraft which are now being built or planned (prototypes are flying in Europe and the U.S.S.R.) will fly in a relatively quiescent region of the atmosphere where any particles emitted, or formed by reactions involving gaseous emissions, could reside for an estimated one to two years. Estimates of the steady-state loading of particles which could result vary over a range of more than a hundredfold, because engineers produce differing estimates of the composition of the exhaust, and because meteorologists are uncertain of the detail and rate constants of the postulated chemical reactions and to a lesser extent of diffusion and residence times. The median of the concentration calculation is, however, disturbingly high; the computed concentrations of particles and water are sufficient to lead to local temperature changes and perhaps even to visible cloud formation.

It is not possible to say what the ultimate effect on climate and weather might be; the optimistic view that the man-in-the-street would notice nothing more than an increased frequency of spectacular sunsets cannot be confidently refuted. But there is an imminent prospect of a measurable environmental change. Clearly, we would be unwise not to document such an environmental change; we should at the same time provide data needed for research into the detailed nature and possible consequences of such a change in the composition of the atmosphere. Accordingly, the recommendations of S.C.E.P. were:

1. Continuing measurement by aircraft and balloon of

Data on which the chart opposite is based are expanded, below, in an effort to determine the sources and sinks of atmospheric carbon dioxide detected at the Mauna Loa, Hawaii, station. The seasonal variation in CO_2 is obvious and its cause may be inferred; but computations of the potential annual increase in CO_2 due to the burning of fossil fuels suggest that processes to reduce the atmospheric burden are at work. (*Chart:* Man's Impact on the Global Environment)



the water vapor content of the lower stratosphere. The height range of particular interest is 60,000-70,000 feet. The area coverage required is global, but with special emphasis on areas where it is proposed that the S.S.T. should fly.

2. Sampling by aircraft of stratospheric particles with subsequent physical and chemical analysis.

3. Immediate development of monitoring by lidar of optical scattering in the lower stratosphere, again with emphasis on the region in which heavy traffic is planned.

4. Monitoring of tropospheric carbon monoxide concentration, because recent theory suggests that atmospheric CO is destroyed in the lower stratosphere by a process of oxidation and reduction which affects the chemical composition of the lower stratosphere and might complicate the interpretation of measurements.

It is perhaps appropriate to comment on the third recommendation. Even if the highest estimates of the possible increase in the stratospheric particle load prove correct, the amount of matter concerned will still be small compared with that often present in the lower atmosphere. Measurements of the total attenuation of solar radiation by the atmosphere would not offer a sensitive test for an increased stratospheric particle load. Optical radar (lidar) offers a possible ground-based method of monitoring stratospheric aerosol. It has been used by many investigators, but hitherto in a relative mode, where an assumption of negligible particle scattering is made in a comparatively clean layer and the remaining layers are related to this. Absolute results can be extracted in principle by integrating attenuation along the beam, but unless the lower atmosphere is particularly clean, uncertainties in the "correction" would considerably outweigh any variance in the signal. The S.C.E.P. recommendations do not specifically include airborne scattering measurements, but these are quite feasible and would be a valuable addition to the proposed monitoring.

Local Effects on a Global Scale

The remaining three problems listed by the S.C.E.P. panel have in common the peculiarity of being a collection of numerous local problems rather than a single

unified global threat. For this reason it is difficult to specify any system of monitoring.

The escape of nutrients, leading in time to eutrophication of lakes and estuaries, could be—and to a large extent is—monitored by recording the composition of major sewage outfalls and industrial waste discharge. The global threat is that a sufficient number of estuaries should be so heavily affected that oceanic species relying on this habitat during one phase of development would be threatened. The problem can be monitored and corrective action can be taken on a local basis, and so long as this is being done in sufficient localities, there is little merit in coordination of methods for its own sake.

The situation concerning oil pollution of the sea appears to be similar. It now seems unlikely that this pollution could significantly affect evaporation rates, with consequent climatic effects. Major oil spills—and subsequent cleansing activities—have been observed to cause catastrophic ecological change locally, but the extent of the threat in the open oceans is not known. One task of an ocean baseline sampling program would be to look for oil and its degradation products and to assess the need for monitoring, though it is not at present clear how effective monitoring could be instituted.

One cause for concern is an interesting example of the complexity of some pollution problems. The chlorinated hydrocarbons, which we know to have spread into the oceans, are much more soluble in oil than in water; they might become concentrated at the surface of the oceans in oil slicks and films, rather than spreading through the mixed layer. Here, in the region of maximum photosynthesis, they would more readily enter the food chain.

Physical and thermal changes at the earth's surface might lead in a variety of ways to serious global problems; at present they have more the nature of threats to local amenities. Dredging and industrial operations in coastal waters, if greatly increased, might bring the same problem as estuarine eutrophication—massive interference with part of the life cycle of some oceanic species. A major increase in human population might bring pressures for destruction of wide areas of the tropical forests, which would certainly modify local weather and might lead to global climatic change. The same effects could follow increases in energy conversion in the course of human activity; according to present projections one area of 350,000 sq. mi. in the United States could by the turn of the century be dissipating heat at a rate equivalent to about 5 per cent of the solar radiation now received at the ground. The corresponding figure in smaller areas—e.g., the 4,000 sq. mi. of the Los Angeles basin—could be as high as 20 per cent. Monitoring these effects should be possible by reference to economic and land-use statistics and their projections; if this could not be satisfactorily arranged for any reason, surveillance from artificial earth satellites is certainly practicable even with present techniques.

Some Remaining Doubts

In surveying recent discussions of global environmental monitoring, it becomes clear that there is a considerable measure of agreement on the problems which make monitoring necessary. They are those we have discussed. It also appears that monitoring techniques are available commensurate with our current understanding of the problems. But this should not lead us to be complacent about our monitoring abilities; there may be threats to the environment which we have not observed simply because we do not have the techniques to observe them. We may postulate, however, that any unobserved threats are so because we have not used systematically the techniques now available to us. Certainly we cannot at present suggest optimum monitoring systems, simply because we do not have broad surveys of the global environment using available techniques—what we have called the baseline.

A further, and much more fundamental, obstacle to the design of an optimum global monitoring program is our lack of understanding of the extremely complex interactive systems with which we are faced—the dynamics and thermodynamics of the whole fluid envelope of the planet, the interdependence of all forms of life on each other and on their inanimate surroundings. The physical and biological problems have much in common—the phenomena of "feedback," positive and negative, amenable to mathematical abstraction in terms of sets of simultaneous nonlinear partial differential equations. Solutions of these problems, if indeed they are soluble, are far in the future; at present we must rely to some extent on an intuitive assessment of possibilities.

A curious feature of recent exercises such as S.C.E.P. which bring together workers in several disciplines is the differing intuitive appreciation of their respective problems by the physicists and the biologists. The former tend to believe that they are concerned with an inherently stable system; climates change, but at their own pace and in their own way, and responses to an internal perturbation are essentially stabilizing. They assume that a physical system with countless degrees of freedom and all time in which to sort them out is likely to have found a very stable state. On the other hand, the biologists seem, in general, to take the view that ecosystems are essentially unstable and that the response to an external perturbation will be large. They add the judgment that the response is also likely to be deleterious. The argument seems to be that just as imposed mutations are usually deleterious and often fatal in individual species, so in ecosystems imposed change is almost certain to lead to destruction. The biologists have some facts to support their position, although in the well documented examples the external perturbation has been gross.

The difference in intuitive appreciation of the problem leads to a fundamental difference in the approach to monitoring. Most atmospheric physicists would agree that a man-made threat to the global climate cannot be monitored by observations of the climate. Many biologists, on the other hand, firmly advocate as a monitoring measure the creation of reserves in various areas biologically typical of a wide region of the surface of the planet, and the observation in detail of life in these reserves.

The Organization of Global Monitoring

There is now a strong case for the study of global monitoring as a single integrated problem. Inevitably any such statement leads to consideration of international agencies for coordination, or even international institutional direction. Such a study need not be an international exercise, but its conclusions would find more ready acceptance if it were sponsored by some established international body. It could hardly avoid the problems of implementation.

In one respect the time seems ripe for international action. Reference standards and methods of observation must be established, coordinated, and preserved so that measurements in different parts of the world are strictly comparable. Thus, there is now a task for an international laboratory charged to house standards and to develop, recommend and compare monitoring methods. The final S.C.E.P. recommendations made clear this opportunity:

1. We recommend the development of new methods for gathering and compiling global economic and statistical information which organize data across traditional areas of environmental responsibility, such as air and water pollution. We further recommend the propagation of uniform data-collection standards to ensure, for example, that industrial-production data collection across the world will be of comparable precision and focus.

2. We recommend a study of the possibility of establishing international physical, chemical, and ecological measurement standards, to be administered through a monitoring standards center with a 'real-time' data analysis capability, allowing for prompt feedback to monitoring units of information affecting measurement parameters, levels of accuracy, frequency of observation, and other factors.

3. We recommend an immediate study of global monitoring to examine the scientific and political feasibility of integrating existing and planned monitoring programs and to set out steps necessary to establish an optimal system.

Before coming to the U.S. in 1968, Dr. Robinson was for 30 years associated with the British Meteorological Service; for the last 10 years of this period he was Deputy Director in charge of research in physical meteorology and instrumentation. A graduate in physics from the University of Leeds (Ph.D., 1935), he was President of the Royal Meteorological Society from 1965-67. Since coming to the U.S. he has been associated with the group first developed by the Travellers Insurance Companies and now organized independently as the Center for the Environment and Man, Inc., where he directs the program in atmospheric physics and chemistry. Dr. Robinson was a group leader in the 1970 M.I.T. Study of Critical Environmental Problems.

". . . he was unable to prevent himself from describing his behavior in idealized, pseudo-objective terms. Why? Because this was the language he had been taught so well and for so long in engineering school."

Conventional descriptions of the process of engineering design are found by experiment to be far removed from reality. There is a correspondingly large gap in the professional training of engineers

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The Unexplored World of Engineering Design

This article is, first, a report of an attempt to simulate the engineering design behavior of a single individual, a practicing mechanical engineer. Second, it presents some reflections, arising out of this experiment, on certain shortcomings in the conventional training of engineers.

As a simulation, the experiment was unsuccessful; and this is what was interesting, for the experiment incorporated to the best of our ability all the current wisdom on how engineering design is done. With the growth and development of the study, almost every one of the study's initial hypotheses was proven false, and it was only out of these "negative results" that the final set of positive hypotheses emerged. The importance of occasionally reporting "negative results" can thus not be overemphasized. (It might be extremely useful if someone actually launched that *Journal of Negative Results* that people talk about so light-heartedly. The point is seriously discussed in David Bakan's *On Method*.)

The Study

I shall try to describe the experiment as it actually happened. Most descriptions of scientific research bear as little relation to the way science actually gets done as the multiplication table does to the way people actually multiply numbers in their heads. If the literature on research were to be taken at its face value, we would be forced to believe that the scientific enterprise is little more than a straightforward matter of subjecting clearly formulated hypotheses to clearly formulated experimental and statistical tests, and generalizing the results into formal or quasi-formal laws which follow quite logically from the initial hypotheses.

Of course, to those of us who are reflective about what we actually do, it is obvious that the real story is vastly more complicated and a lot less straightforward. For one thing, we know that the supposedly distinct stages of the scientific enterprise—hypothesis, experiment design, observation, and the rest—are, more often than not, all confused and blurred together. We know that only half of the scientist's job (if even that much) is concerned with the actual collection of data and with the actual testing of clear ideas. One of the scientist's biggest and most difficult tasks is finding out which ideas he should test, and which data should be collected to test which idea. Mother Nature does not give away her secrets for nothing.

The kind of engineering design that we investigated was the design of pressure vessels. The original aim of the study was to build a quantitative model that would simulate as far as possible the entire design process, from the time when a design was first conceived to the final blueprint, and would itself thus produce the same design solution as the engineer.

The first problem was where to start. It was not only a question of what kind of model one built; it was more a question of what kinds of factors one included in it. Of course, it might be thought that, since engineering design was essentially a rational activity governed by physical and economic laws of engineering, these questions might almost answer themselves—that the engineer's design problem, stated in enough detail, would entirely govern the way he went about achieving a technical solution. But perhaps not. Would different engineers use different design equations, or were the laws of engineering truly universal? Perhaps something from behavioral psychology should go into the model? Furthermore, almost every engineer works as a member of some group or organization, so in order to predict his final design output, perhaps one should also include social factors?

As in any study, one goes to the literature for guidance. The literature on engineering design implied that, instead of looking at the engineer as a creature with a psychology, we should look only at his design equations, and this should give us enough of the reality of design so that the model's behavior would resemble the engineer's behavior quite closely.

After many months of observing what the engineer did in various design situations, we felt that enough equations had been collected to put them into a computer and then sit back and watch the computer plunk out designs just as the engineer did them. The day of truth approached. The computer was fed the same set of technical input data that the engineer had encountered on one of his past problems. When its output was finally examined, the computer showed that in addition to the solution that the engineer had converged upon, there were also approximately 30 others, every one of which would have satisfied all of his rules for a possible solution.

Clearly, the engineer was using some rule to choose be-

tween the various alternatives, for he had finally decided to build one and only one. The question was: What additional rules was he using?

We went on like this for a few more months, learning about the engineer's technical design methods and transferring them to the model, adding rules here and subtracting rules there. At the end of this period, we were no better off than when we started. The computer was still putting out about 30 solutions to the engineer's one. It seemed as if we could go on adding technical rules forever, without ever discovering what it was that guided the engineer. Was I asking the wrong questions of the engineer? Was he lying, both to me and to himself?

The Personal Equations

Both these questions were answered in the affirmative. I had been asking the wrong questions, and the engineer, although completely unaware that he was doing so, had been lying both to me *and* to himself. The technical equations that the engineer used were only half the story. How he used them was the other half. It turned out that, depending on who his particular client happened to be, the engineer not only used his equations differently, but also used different equations. And in addition to his purely technical equations there were also his own personal equations. Let me illustrate.

On the whole, it seemed that most of the engineer's clients fell into one of two classes—those that overdefined their design requirements, and those that underdefined them. The overdefiners literally made any solution impossible. No design could simultaneously satisfy every one of their rigid constraints. The underdefiners, on the other hand, made too many solutions possible. (The underdefiners would say something like, "Make the design as small and as thin as possible." The overdefiners would say something like, "Make it 2.00 in. $\times$ 3.00 in. $\times$ 4.00 in., 0.003 in. thick, and costing no more than $0.20.)

The engineer's biggest problem was thus to get his clients to redefine their problems. This he attempted to do by finding out what it was they really needed. Unfortunately, many times this only made the process go round in a circle. The more the engineer asked the overdefiners about their needs, the more they attempted to justify their initial requirements.

Essentially, the overdefiners' biggest problem was that they thought they knew more about design than the engineer did. Perhaps the classic case was the overdefiner whom we will refer to as X. X had more than once boasted how he knew more about design than the engineer did and how he always got exactly what he wanted. One time after X had departed, the engineer turned to me and said, "We'll fix that old S.O.B. We'll give him the same bucket of bolts we always have and he won't even know the difference. He never does." I should emphasize that most cases are nowhere near this extreme. But many times an overdefiner would go so far as to give the engineer a detailed sketch of what he wanted, with the rather ungracious command, "Build it!"

In such circumstances, the engineer did what he could to point out the inconsistencies of their demands. But, since the clients were "always right," in the long run the engineer instead gave them what he *thought* they wanted—often to their distinct disadvantage. The unwritten motto of the engineer's group was, "We always try to give our clients what they want, even when it is not what they need."

With the underdefiners, it was a completely different game. Whereas the overdefiners overreacted to the engineer's advice, the underdefiners underreacted. One extreme was no better than the other. In the former case there was nothing left for the engineer to assume, in the latter case there was everything. Accordingly, the engineer played a game of detection. He half gave the underdefiners what, from his past experience, he thought they needed, and he half gave them what *he* wanted, i.e., what would be most convenient to design and to build from his point of view. He rationalized this procedure on the ground that if something were really important, it would be important enough for them to spell out in detail. Unfortunately, as the engineer himself admitted, many underdefiners did not underdefine by choice or as a trait of personality. Many didn't know enough about the process of design to know what was of importance, and hence what they should specifically request.

No wonder the computer didn't match. The engineer was using all of these "personal equations" to modify literally *every single one* of his technical design equations. And nearly all cases involved at least some form of bargaining (it could conceivably be called "mutual education") between the engineer and his client.

It should be understood that this engineer's clients had just as much technical training as he did, if not more. Where the engineer had only a B.S. in mechanical engineering, his clients usually had their Ph.D. in physics. When one observes two highly trained observers disagreeing over the "state of nature," it greatly helps one to realize that the state of nature is not simply the state of some generally agreed upon and abstract system of equations: it is largely a matter of whose equations one is looking at.

So much for the hypothesis that design is a *wholly* rational process that can be described in technical terms alone. Literally every facet of the technical process was permeated with the engineer's personal feelings and evaluations. Not only did the use of every one of his technical equations call for his personal judgment with respect to the magnitude or relevance of a particular factor, but he also had a choice as to which equations to use. Engineering design is still so much an art that many of the equations are no more than mere rules of thumb. And many thumbs have had a role in their formulation, so there are many equations to choose from.

Design Sociology

Among our working assumptions regarding the world we live in—both the world at large and the specialized worlds of our professional work—there are some that

are so commonly taken for granted, so deeply ingrained, that we are almost never aware of them as assumptions. And if our attention is drawn to them, we are inclined either to dismiss outright the legitimacy or fruitfulness of the study of these assumptions, or to relegate that kind of study to philosophy—thereby saying, in either case, that such a study is neither of concern nor of importance to engineering. This is one of the positions that is being challenged here.

René Dubos, the Nobel Prize-winning scientist and philosopher, writes: "the most influential assumption of modern science is that the best and indeed the only scientific approach to the study of natural phenomena and of living organisms is to divide them into fragments and to investigate elementary structures and properties in greater and greater detail." There are really two assumptions in one here. The first is that it is *possible* to study a complex situation in this way; the second is that this is the best and only scientific way. A third common unspoken assumption is (in spite of Heisenberg's principle) that the observer is independent of the phenomena he is measuring—that effects due to the presence of the observer can be clearly separated out and distinguished from the observed phenomenon itself. A fourth assumption is that *physical* events can be strictly separated and distinguished from *psychological* events.

Our design-simulation study very strongly contests *all* of these assumptions. Consider the last one. The engineer was initially represented—in conformity with the literature of engineering—as a physical transducer, a set of technical design equations whose function it was to transform some clearly specified and "given" technical input into a final design object. His client also was represented in completely technical terms—the variables supposedly defining all of his design needs. Thus, a strict partition between physical and psychological variables was presupposed from the very beginning; and it was further assumed that human behavior could either be neglected or reduced to physical terms. Thus, physical phenomena and processes were supposed to be overwhelmingly predominant. Unfortunately, the study conformed to neither this nor the other assumptions. It was these disconformations that constituted the study's "negative results"—the simulation's failure to represent reality.

It turned out that, in the first part of the engineer's design process—the generation of potential design solutions or alternatives—the engineer's technical behavior was relatively, but only relatively, independent of the client's personality; the client's needs could, after a fashion, be represented simply as a technical input.

But in the second part of the process—in which a final design alternative was selected—neither the client's needs nor the engineer's design behavior could usefully be represented by independent technical variables and processes alone. Social and technical behavior were so intermingled that it was almost impossible to say where the one left off and the other began. Likewise, the behavior of each party, both physical and social, was so strongly coupled to that of the other, that here again it was almost impossible to say where the "internal" properties of the one party left off and where the "external" inputs from the other party began. In short, the properties of neither one of the basic components of the design process (the engineer and the physicist) could be measured, let alone understood, independently of the other.

To the social psychologist, this is of course nothing new. Indeed, studying how human "components" interact in group situations is one of the major techniques for measuring an individual's properties. But social psychology is generally regarded as having nothing to do with practical engineering.

This leads me to the heart of one of my major criticisms of current models of the engineering design process (E.D.P.). By far the vast majority of empirical and theoretical studies on the nature of the E.D.P. have either directly attempted to break that process down into a number of components, or they have assumed that this can and will be done. The vast majority of these studies have also assumed that, because the output of the E.D.P.—the design object itself—can be fully described in technical terms (over this there is no argument), an adequate description of the designer and the organizational environment in which he works can also be effected in these terms. To put it philosophically, such studies are predicated upon mechanistic and reductionistic assumptions.

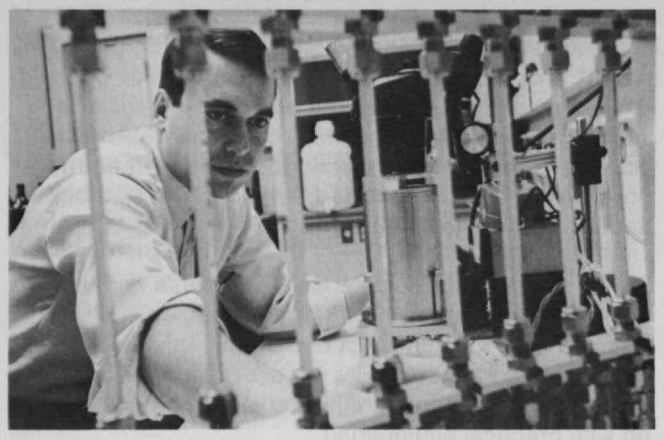
Whether the theorist of the E.D.P. is aware of it or not, in postulating and constructing a theory of the design process, he is assuming more than his natural role of an engineer; he is also assuming the role of a philosopher and of a behavioral scientist.

What is called for is a research strategy for translating this realization into an actual plan for supplementing current models of the E.D.P. Furthermore, it will have to be the kind of behavioral analysis that includes and accounts for not only the rational, conscious aspects of behavior but also the irrational and unconscious aspects.

In part, such an investigation is proceeding now. The question we are asking is whether the adoption of more sophisticated psychological techniques and models (for example, techniques commonly used in clinical psychology) will enable us to simulate the design process with greater predictive success.

The Wrong Language

One of the questions being pursued in greater depth is why different personality types start with different "givens" in the formulation of the same engineering problem. This brings up the basic question of how to characterize something so elusive as a personality type. In reality, there were of course many more types of physicists than just "overdefiners" and "underdefiners." The analysis and classification of the personalities of engineers and their clients, in relation to their styles of approach to technical problems, deserves a study of its own. It appears that (at least in the spe-



". . . one of the reasons why engineers and physicists have had such difficulty in interacting is that, in thinking about the same physical thing, they start from radically different sets of 'givens.' In more ways than one, they are the prisoners rather than the masters of their respective insights into nature." (Photos: Ivan Massar from Black Star)

cific situation we studied) one of the reasons why engineers and physicists have had such difficulty in interacting is that, in thinking about the same physical thing, they start from radically different sets of "givens." In more ways than one, they are the prisoners rather than the masters of their respective insights into nature.

For instance, earlier I referred to the engineer's "lying" both to me and to himself in describing his design methods. The reason was that he was unable to distinguish verbally between what he actually did and what he would have liked to have done. What he actually did was far removed from what he said he did (and even further removed from what he would have liked to have done). But he was unable to prevent himself from describing his behavior in idealized, pseudo-objective terms.

Why? Because this was the language he had been taught so well and for so long in engineering school. To recognize such a discrepancy and to point it out—in the way that is least threatening to an individual—is part of the function of the clinical psychologist.

There would appear to be a need for critical analysis of some of the major assumptions underlying engineering education, and especially a critical look at some of the attitudes engineering education has tended to foster.

Of all the basic assumptions of engineering education, the one that most deserves re-evaluation is the assumption that, because engineering is problem-oriented, engineering design is best taught through the solution of countless problems. This may indeed be the case—but it depends on what we use as "problems." Most, if not all, of the problems given to engineering undergraduates are such as to require only a single answer. That is, they are already so perfectly defined that they prohibit the student from playing the kind of active role that he must perforce take on in real life. They are problems in name only. One result is that the student comes to expect a certain kind of "givens" at his starting point. These givens are peculiar to the academic view of the field of engineering concerned. Little wonder that fields that teach their givens in different ways perceive one another with such mutual suspicion. Also, little wonder that the notion that problems start with certain givens is so deeply ingrained.

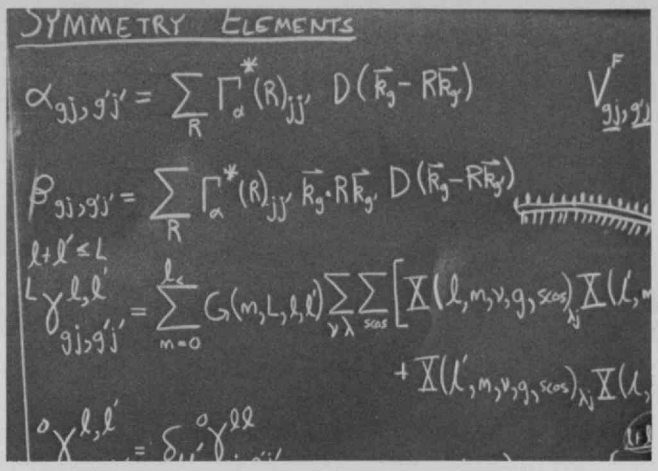
Much of this is directly the fault of us, the teachers. We have contributed to the myth that systems are really "out there"—that what things really are is independent of the way we (the observers) look at them (the objects). But in fact, what one observes depends upon what one has been trained to observe. All those boxes on our flow charts that are supposed to describe the world are no less a description of our own peculiar background.

Training for Real Life

One of the things that is called for is the explicit recognition of the greater and in fact fundamental role that the behavioral sciences have to play in the education of engineers. Incidentally, the time is way past for physical scientists and engineers to keep asking whether the behavioral sciences are even "sciences," let alone whether they have anything to contribute. These are no longer fruitful questions. For those who believe that the physical sciences are universally "hard" and that the behavioral sciences are perpetually doomed to be "soft," Olaf Helmer and Nicholas Rescher's excellent paper entitled "On the Epistemology of the Inexact Sciences" (*Management Science,* Vol. 6 [October, 1959], pp. 25-52) should be required reading.

The training of engineers must incorporate problems such as really arise in the practice of the profession, complete with their humanistic and behavioral components—that is, problems that do not permit of any final solution unless all of these components are considered explicitly and simultaneously with the technical questions. Hopefully, the setting up of such problems could help to integrate the humanities and the behavioral sciences into the main body of engineering education. For example, it would be much more useful to a student engineer to have to solve the "same" technical problem for ten different kinds of clients, and compare the solutions, than to sit through ten hours of lectures on social psychology which leave the concrete connection with engineering design, at best, vague.

But I think that even more is required. One of the things I've really been suggesting all along is that there is a need to merge the two roles, that of the engineer and that of the psychiatrist or clinical psychologist, in a single individual. The kind of psychology I learned in "engineering-psychology" (in which the psychology was mostly experimental rather than clinical) was not ade-



quate to the task of building a unified theory of the engineering design process that would account for the unconscious, irrational aspects of the process as well as for the conscious, rational aspects.

We may have to go further still. We may have to consider such even stranger beasts as the engineering-anthropologist. For example, the process of building a model for a proposed highway begins by abstracting from nature a technically solvable problem. In this process, the people the highway is intended to serve always seem to get left out. Somewhere along the way, the local citizens always get converted into "entities," "consumers," or "subjects." Their all-too-human needs become "inputs"; their cherished life-goals become "future system states." In this process of abstraction, the highway engineer never sees the real community as it actually exists; he never feels its life-style, knows its people, or walks its streets. He is a stranger to their customs and their way of life. How then can he pretend to know enough about them to be able to design what will be best for their community, let alone what will be best for the system as a whole?

I suggest that we may have to train our future engineers (or at least some of them) in anthropological field methods. Before we let them draw a single line, we may have to send them out to live with the community they are to serve, and for months if need be. They will have to learn how it is to breathe *its* air, eat *its* food, and respect *its* customs, symbols, totems, and taboos. They will have to learn the limitations of their own strange magic when viewed from outside the design shop—that, for example, the richness of a way of life can be only partially captured at best by input/output analysis.

I am sure that many who have read this paper will ask whether I have not been unduly loose in my use of the term "design." Has it not been made so all-encompassing as to become meaningless? Surely everything that goes on in and around the engineering design process is not thereby design?

I can no longer give as clear a reply as I would once have been foolishly quick to offer. All I can say is that the further some of us delve into what goes on "inside" the design process proper, the more we are forced to include factors traditionally regarded as "outside" the profession, in order to explain what does indeed go on inside. And one thing we do know is that traditional engineering education has not been adequate in even posing these questions, let alone beginning to answer them.

The recent widespread layoffs of engineers and scientists make the substance and arguments of this article painfully immediate. They are no longer matters of pure academic concern. The implication that deserves our most serious consideration is: The decline of the economy may only be the immediate culprit in the recent layoffs. The long-run and more serious culprit may be the educational philosophy underlying engineering education. Engineers and engineering educators may be kidding themselves if they think that by making trivial educational adjustments they can "re-tool" engineers to fit new jobs. It is not clear at all that engineers and scientists can be quickly or easily re-tooled to work on such problems as pollution, crime, city planning—to mention only a few problems. The basic difference that distinguishes these problems from the kinds of problems that engineers and scientists have been traditionally trained to solve is that these problems are, inseparably, as social (or behavioral) as they are technical. In short, they are the kinds of problems that call for the kinds of new engineers described in this article. If engineers think that they can even identify, let alone work on, the technical components of these problems independently of a thorough *personal* knowledge of the social components of these problems, then they may indeed be in for the rudest of awakenings.

In closing, I think a few words about my own education are very much in order. It is probably obvious to the reader by now that one of the most influential factors in this study's growth and development was this author's formal studies in the philosophy of science, especially the philosophy of the social sciences. The more I studied the social sciences, the more I realized how futile it would be to go on searching for a useful description of the design process in purely technical terms. But even with extensive training, a reorganization of one's perceptual field is still extremely difficult. As an engineer I had been so trained to look at the world in purely technical terms that it constantly required all my powers of concentration to observe things from a new perspective.

Nature is not organized in the way that universities are. This is a hard lesson to learn. It is even harder to learn how to translate this aphorism into a way of educating engineers. But this is the task facing us.

Ian I. Mitroff received his Ph.D. in Engineering Psychology from the University of California at Berkeley. He is currently an Associate Professor in the Graduate School of Business and Interdisciplinary Doctoral Program in Information Science at the University of Pittsburgh, and a Research Associate in the University's Philosophy of Science Center. His research is concerned with the mathematical modeling of philosophical "inquiring systems" and the philosophy-psychology of science.

When Jules Verne wrote From the Earth to the Moon *(1865), he guessed correctly that the Smithsonian would be somehow involved. The photograph was taken by the Smithsonian Astrophysical Observatory's satellite-tracking station at San Fernando, Spain. It shows the 450-mile-wide cloud of oxygen dumped by the S-IVB stage of Apollo 8, which was then 50,000 km. from Earth. The smaller cloud is residual venting from two thrusters. The spacecraft is visible between the two clouds.*

. . . an astounding piece of intelligence burst like a thunderbolt on every part of the Union: The Projectile Had Been Seen!

It is needless to say that the Atlantic Cable instantly flashed the news to all parts of Europe, in fact to all parts of the world within reach of telegraphic communication.

* * *

'To the Regents of the Smithsonian Institute, Washington, D.C.

'GENTLEMEN:

I have the honor to inform you that the projectile, discharged by the Columbiad at Stony Hill, has been perceived this morning at three (3) hours, twenty-seven (27) minutes, and thirty-six (36) seconds after midnight, by Messrs. McConnel and Belfast, of the Cambridge Astronomical staff, at present on active but temporary service at this Observatory . . .'

With what breathless eagerness this dispatch was read in the evening papers! What an infinite number of startling questions was called forth by this totally unexpected dénouement! What investigations of a palpitating interest should henceforth await the watchful eye of science! A problem had been resolved, marking a new era in the world's annals, and, like the discovery of America, destined to modify our history forever. Thanks to the courage and the sublime devotion of three men, the enterprise of sending a bullet to the Moon, instead of being put off to future ages, like other so called Quixotic projects, was now a living accomplished fact.

* * *

The names of Barbican, McNicholl and Ardan should be henceforth and forever written in letters of living light on the brightest pages of astronomical research. In the far off ages of the future, when so many other illustrious names shall be extinguished in the black waters of oblivion, these three men shall stand forth as the representatives of an age of profound investigation, most painstaking industry, and unparalleled audacity. It was only such an age that could have given birth to explorers so daring, engineers so accomplished, and lovers of abstract science so singularly pure and unselfish!

It must be acknowledged, however, that lofty sentiments of this kind were confined to the scientific, the learned, the aesthetic, the cultured classes . . .

As visible astronomical objects, spacecraft have contributed to astronomy by helping to test new techniques. Besides which, eye and camera are still the best equipment for some purposes

Michael P. Charette

Apollo through the Telescope

In the fall of 1968, a group composed of both professional and amateur astronomers throughout the world was formed for the purpose of optically tracking the Apollo 8 spacecraft. A number of persons, including myself, had tracked earth satellites before 1968 for the Smithsonian Astrophysical Observatory's Moonwatch Program, and tracking Apollo spacecraft was a natural extension of this work.

Drs. James O. Cappellari, Jr., and William I. McLaughlin, of Bellcomm, Inc.,—to whom I am indebted for information and photographs for this article—coordinated the astronomers' efforts and supplied the necessary predictions of the spacecraft's positions over the entire Apollo 8 mission, and analyzed the optical data, under a N.A.S.A. grant. The success of the Apollo 8 tracking led to the continuation of the program through Apollo 14.

One might ask, Why track the Apollo spacecraft optically? There is more than one answer, quite aside from fulfilling Jules Verne's prophecy almost to the letter.

First, N.A.S.A. is investigating the feasibility of optically boresighting on spacecraft over great distances. This is a necessary prerequisite for laser communication between astronauts and earth.

Second, optical observation is the natural way to study the jettisoned wastes which sometimes obstruct the view *from* the spacecraft. On-board electricity is provided by hydrogen-oxygen fuel cells, which produce water as a by-product. Some of this water is used by the crew for drinking and cooling, but there is a large excess which must be periodically dumped overboard. The dumped water immediately forms ice, which tends to remain in the spacecraft's vicinity and creates an "atmosphere." It can have serious consequences for photography, by causing fogging of the windows. And there is the "firefly effect" first described in 1962 by John Glenn: the ice crystals appear as stars in the sextant, making navigation difficult. In another area, engineers planning the mounting of external experiments on Apollos 15, 16, and 17 and Skylab are concerned with how waste water might affect equipment such as mass spectrometers and the Skylab-Apollo Telescope Mount. Although the experiments will be protected by covers, photographic and photometric brightness-versus-time measurements of the water dumps can assist in the design of these covers and in determining when experiments should be operated.

The same kind of observation—basically, watching a cloud disperse—is also useful in investigating possible volcanic ventings on the moon, such as in Aristarchus, and contributes to the study of the physics of interplanetary grains and particles. Recently, various gas clouds associated with comets have been observed, and the dump-dispersion results could be applicable, analogically, to these gas clouds.

In another area, the use of sensors in various spectral regions on water dumps has particular value to planetary science. We can compare the optical spectra of the water dumps with those of planetary bodies, and thus learn something of the latter's composition. The grain sizes of the ice crystals can also be determined using such photometry, and can be applied to studies of comets and of Saturn's rings.

Optical observations are also used to track the Saturn IVB booster rocket. Its orbit is poorly defined after the lunar module (L.M.) is withdrawn, because of the extremely short life of the S-IVB's transponder batteries. Better orbital data is needed for the seismic experiments in which the S-IVB's impact on the moon is used to generate seismic waves in the lunar crust.

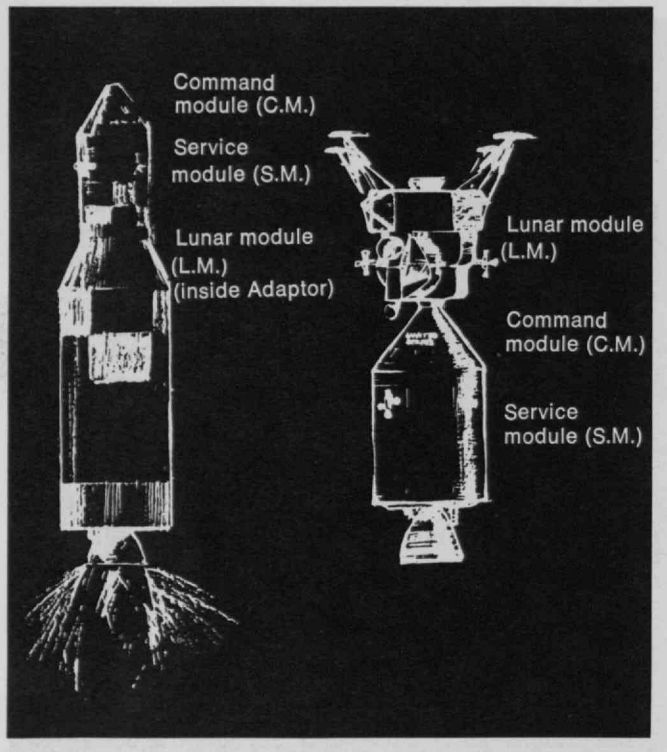
Finally, telescopic observations can confirm various mission events. A graphic example of this was the observation of the Apollo 13 explosion by several observatories in the United States and Canada.

Apollo 8

The first opportunity for tracking a lunar mission occurred on Apollo 8. The Smithsonian Astrophysical Observatory's Baker-Nunn camera station on Maui, Hawaii, photographed the spacecraft as its translunar injection (T.L.I.) burn was in progress, moving it out of earth-orbit and into its moonward course. The sunlit exhaust from the S-IVB appeared as a triangular-shaped cloud, moving along with the spacecraft.

After the Apollo 8 T.L.I., the command-and-service module (C.S.M.) separated from the S-IVB. At the same time, the spacecraft lunar-module adapter panels (S.L.A. —they protect the lunar module during launch) were jettisoned. After the C.S.M. moved away from the S-IVB,

Elements of an Apollo spacecraft during the third stage of launch, and after jettisoning the third Saturn stage (S-IVB) and reconfiguration for the long coast to lunar orbit.



the latter performed a "slingshot" maneuver which would cause it to pass within 2,000 km. of the moon's leading edge and enter solar orbit. The S-IVB then vented its liquid oxygen tanks for safety reasons. The Smithsonian's Baker-Nunn camera in San Fernando, Spain, photographed the S-IVB and its liquid oxygen cloud. They were approximately 43,000 km. from the earth, and the cloud expanded to a length of 215 km. and a width of 100 km. Two S.L.A. panels were also seen, flashing intermittently as they tumbled in space.

Later that night, observers in California, Arizona, and New Mexico photographed the C.S.M., the S-IVB booster, and all four S.L.A. panels. The C.S.M. appeared as a point of light, varying in brightness and occasionally flashing. The slow variation was presumably due to the "barbecue-mode" thermal control—the spacecraft rotates at a rate of two revolutions per hour to prevent uneven heating by the sun. The flashes were probably from the windows or other specular surfaces. The S-IVB was generally brighter than the C.S.M. (being larger), but its brightness varied considerably as it tumbled.

This sequence, taken from Mt. Haleakala, Maui, Hawaii, shows Apollo 8's translunar injection burn (taking the craft out of earth-orbit and on to its moonward course). 1) Before the burn: breaks in the track are due to a rotating shutter in the Baker-Nunn camera, for time-measurement purposes. 2,3) The exhaust cloud builds up. 4,5) The burn is now viewed from almost directly behind the S-IVB nozzle. 6) The Apollo goes out of sight behind the mountain. (Photos: Smithsonian Astrophysical Observatory)

Observers continued to view the spacecraft as it coasted toward the moon. The U.S. Naval Observatory at Flagstaff, Ariz., took a photograph of the C.S.M. at a range of 350,000 km., when its brightness was classified as stellar magnitude 15. No water dumps were observed during the flight: flashes coming from the C.S.M. during the return journey were later attributed to a control-thruster test.

Next came Apollo 9. This was an earth-orbit mission, and tested a manned L.M. for the first time in the space environment. After a series of maneuvers, the L.M. docked with the C.S.M. and was later jettisoned. The L.M. then performed a burn-to-depletion which placed it in a 6,500-km. by 250-km. earth-orbit. At that altitude, the L.M. will not return to the atmosphere for another 20 years. I have watched the Apollo 9 L.M. frequently since its March, 1969, launch. Its brightness varies greatly as it tumbles, with occasional flashes probably caused by sunlight reflecting off the windows.

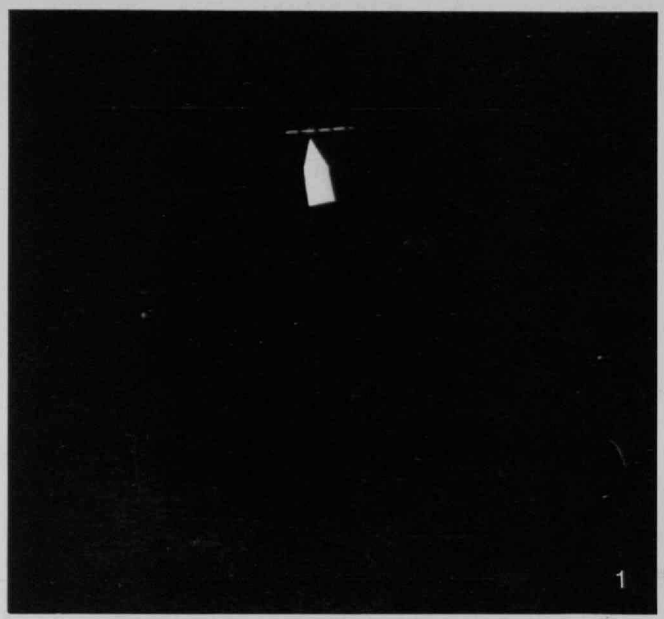
Apollo 10 was the first test of the L.M. in lunar orbit. Several water dumps were delayed slightly during this mission in order to allow a greater number of observatories to sight them, but in fact the weather was uncooperative and no such observations were possible. This illustrates one of the obvious drawbacks of laser communication. However, all of the spacecraft parts were seen at various stages of the flight.

At the end of the mission, two airline pilots who were flying over the South Pacific observed the command module reentering the atmosphere. They also saw the discarded service module burn brightly, then explode as a result of residual fuel in its tanks.

The Moon Landing and After

The Apollo 11 mission was launched in the early morning and consequently disappeared over the western horizon in the evening, during early twilight—only marginally visible. What was a giant leap for mankind in general was thus a rather small step for us: few spacecraft sightings and none of any water dumps.

It was the Apollo 12 flight that broke the record for optical observations up to that time. The orbit was more visible inherently, and weather conditions were generally helpful around the globe. Western European observers photographed and visually observed, in their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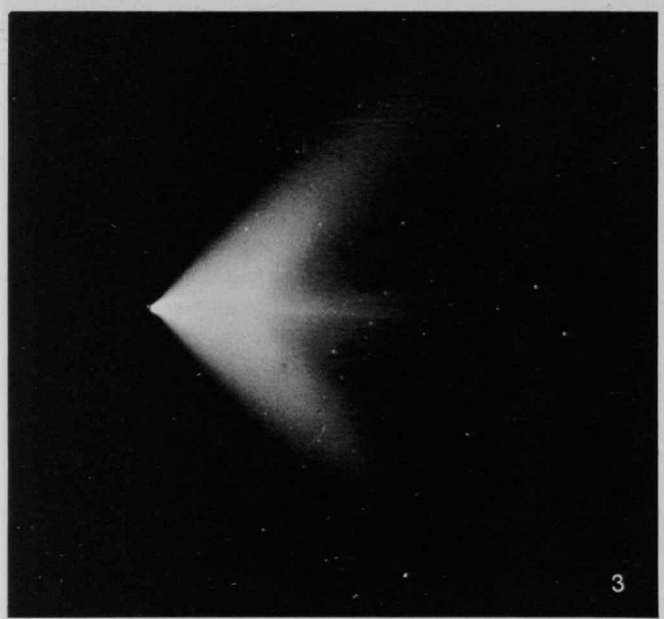
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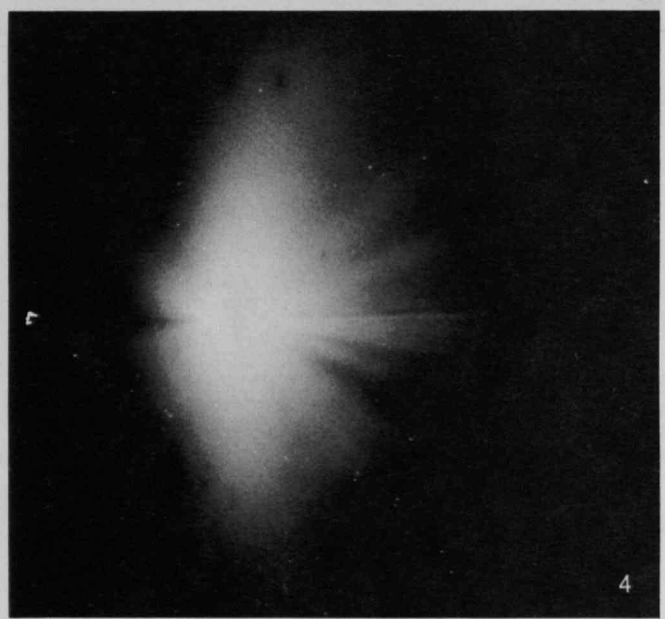
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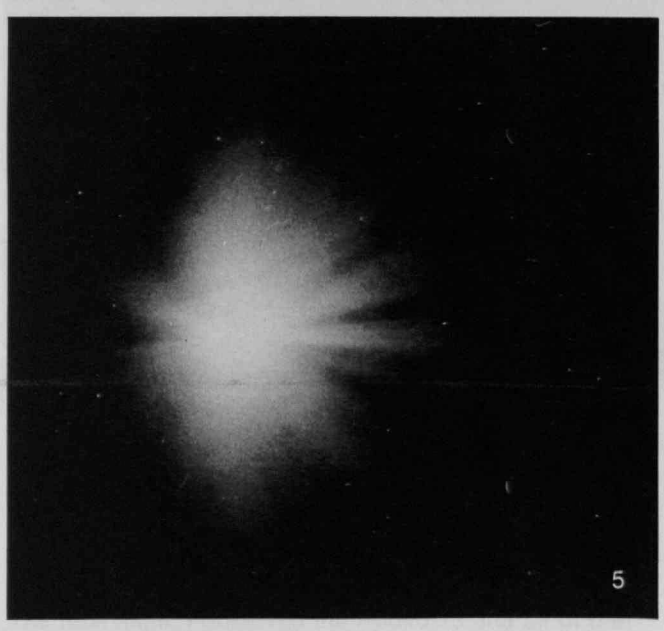
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6

Computer predictions are essential to the successful sighting of the Apollos. This is a typical print-out, for Apollo 14, the last two columns showing celestial coordinates of the spacecraft in right ascension and declination (analogous to longitude and latitude).

GREENWICH DATE	UNIVERSAL TIME	SUN ELEVATION	AZIMUTH	ELEVATION	SLANT RANGE	RT. ASC. MEAN OF 1950	DECLIN.
	(H. M. S.)	(DEG)	(DEG)	(DEG)	(KM)	(H. M. S.)	(D. M. S.)
31 JAN 71	23.40. 0.	-19.	27[illegible].48	19.11	16194.	22.20.11.	16.35.34.
1 FEB 71	0. 0. 0.	-23.	27[illegible].66	20.82	21220.	23.21.17.	23.16. 9.
1 FEB 71	0.20. 0.	-27.	27[illegible].68	26.08	26301.	0. 0. 6.	26.20.38.
1 FEB 71	0.40. 0.	-30.	27[illegible].24	28.24	31241.	0.27. 2.	27.55.44.
1 FEB 71	1. 0. 0.	-34.	27[illegible].19	28.70	36004.	0.46.59.	28.48.29.
1 FEB 71	1.20. 0.	-38.	27[illegible].41	28.15	40596.	1. 2.31.	29.18.48.
1 FEB 71	1.40. 0.	-41.	27[illegible].83	26.93	45032.	1.15. 4.	29.36.14.
1 FEB 71	2. 0. 0.	-45.	28[illegible].40	25.27	49329.	1.25.29.	29.45.46.
1 FEB 71	2.20. 0.	-48.	28[illegible].06	23.29	53501.	1.34.23.	29.50.17.
1 FEB 71	2.40. 0.	-51.	28[illegible].85	21.08	57562.	1.42. 5.	29.51.27.
1 FEB 71	3. 0. 0.	-55.	28[illegible].71	18.70	61521.	1.48.54.	29.50.22.
2 FEB 71	0. 0. 0.	-23.	20[illegible].51	16.04	205051.	3.38. 5.	29. 5.17.
2 FEB 71	0.20. 0.	-26.	21[illegible].16	14.24	206771.	3.38. 4.	29. 3.15.
2 FEB 71	0.40. 0.	-30.	22[illegible].43	11.70	208509.	3.38. 4.	29. 0.58.
2 FEB 71	1. 0. 0.	-34.	23[illegible].89	8.71	210264.	3.38. 4.	28.58.26.
2 FEB 71	1.20. 0.	-37.	24[illegible].34	5.42	212038.	3.38. 6.	28.55.41.
2 FEB 71	1.40. 0.	-41.	25[illegible].38	1.95	213828.	3.38. 8.	28.52.43.
2 FEB 71	2. 0. 0.	-44.	25[illegible].45	8.37	215633.	3.38.11.	28.49.33.
2 FEB 71	2.20. 0.	-48.	26[illegible].84	4.72	217453.	3.38.17.	28.46.13.
2 FEB 71	2.40. 0.	-51.	26[illegible].73	1.04	219285.	3.38.23.	28.42.44.
2 FEB 71	3. 0. 0.	-54.	26[illegible].27	7.34	221128.	3.38.31.	28.39. 7.
3 FEB 71	0. 0. 0.	-22.	18[illegible].46	15.31	300434.	4. 1.26.	27.38.26.
3 FEB 71	0.20. 0.	-26.	19[illegible].50	14.57	301517.	4. 1.18.	27.37.20.
3 FEB 71	0.40. 0.	-30.	21[illegible].28	12.86	302627.	4. 1.10.	27.36. 2.
3 FEB 71	1. 0. 0.	-34.	22[illegible].22	10.42	303763.	4. 1. 2.	27.34.34.
3 FEB 71	1.20. 0.	-37.	23[illegible].68	7.51	304924.	4. 0.55.	27.32.56.
3 FEB 71	1.40. 0.	-41.	24[illegible].25	4.28	306109.	4. 0.48.	27.31. 8.
3 FEB 71	2. 0. 0.	-44.	24[illegible].47	0.85	307317.	4. 0.43.	27.29.10.
3 FEB 71	2.20. 0.	-48.	25[illegible].72	7.29	308547.	4. 0.38.	27.27. 4.
3 FEB 71	2.40. 0.	-51.	25[illegible].27	3.65	309798.	4. 0.35.	27.24.50.
3 FEB 71	3. 0. 0.	-54.	26[illegible].32	9.96	311067.	4. 0.32.	27.22.28.
4 FEB 71	0. 0. 0.	-22.	17[illegible].61	14.19	364981.	4.12.20.	26.32.30.
4 FEB 71	0.20. 0.	-26.	19[illegible].09	13.06	365757.	4.12. 6.	26.31.27.
4 FEB 71	0.40. 0.	-30.	20[illegible].11	12.51	366564.	4.11.53.	26.30.14.
4 FEB 71	1. 0. 0.	-33.	22[illegible].71	10.37	367402.	4.11.39.	26.28.51.
4 FEB 71	1.20. 0.	-37.	23[illegible].90	7.66	368271.	4.11.26.	26.27.18.
4 FEB 71	1.40. 0.	-41.	23[illegible].12	4.57	369169.	4.11.12.	26.25.35.
4 FEB 71	2. 0. 0.	-44.	24[illegible].87	1.22	370097.	4.10.59.	26.23.44.
4 FEB 71	2.20. 0.	-47.	25[illegible].54	7.71	371053.	4.10.46.	26.21.43.
4 FEB 71	2.40. 0.	-51.	25[illegible].43	4.10	372037.	4.10.34.	26.19.34.
4 FEB 71	3. 0. 0.	-54.	26[illegible].75	0.41	373046.	4.10.22.	26.17.17.

evening skies, the liquid oxygen dump from the S-IVB, and later that night American observers for the first time saw the C.S.M. perform a water dump. Justus Dunlap, at Northwestern's Corralitos Observatory in Las Cruces, N.M., used an image orthicon looking through a 24-inch reflector to videotape the event for the mission's permanent record. Other observers saw the C.S.M.-L.M. combination and the usual array of S.L.A. panels.

My own observations during this mission occurred three days after launch. I attempted to observe the C.S.M.-L.M. at a range of 320,000 km. using the 18-inch refractor at the Amherst College Observatory. It was extremely difficult to find any reference stars, because the spacecraft's predicted position was quite close to the brilliant moon. However, I did find a double star near the Apollo 12's predicted track and sketched the field of stars in its vicinity. Ten minutes later I noticed, by using averted vision (that is, looking a little away from the point of interest), that one of the faintest stars seemed to be very slowly moving. Brightness fluctuations confirmed that the "star" was indeed a man-made object of some kind.

Later, when its position and motion were compared with post-flight tracking data, if turned out that I had observed the S-IVB rather than the C.S.M.-L.M. This particular S-IVB failed to perform a normal "slingshot" maneuver around the moon and into heliocentric orbit (old, and therefore incorrect, orbital data were used to guide it). Instead, it went into a high earth orbit with an apogee of 855,000 kilometers and a perigee of 165,000 km. My observations, along with those made at the same time at the Jet Propulsion Laboratory's Table Mountain Observatory, were later used to establish an orbit whereby the S-IVB might be recovered, but in the end efforts to locate the booster failed.

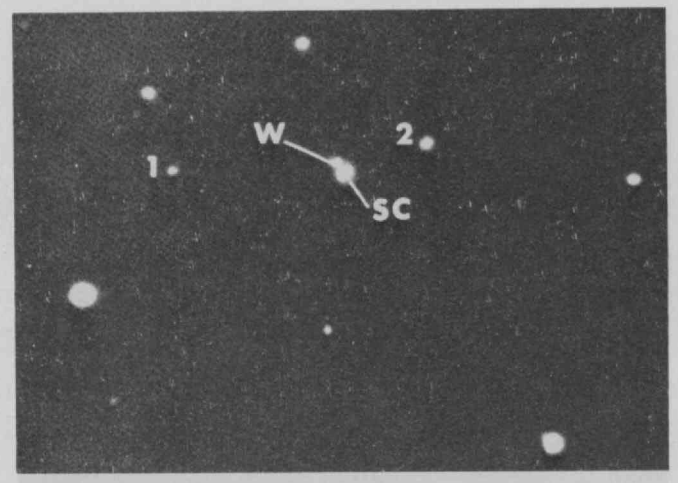
By the time Apollo 13 was launched, the art of observing Apollos had become rather routine, although the events of that mission were not.

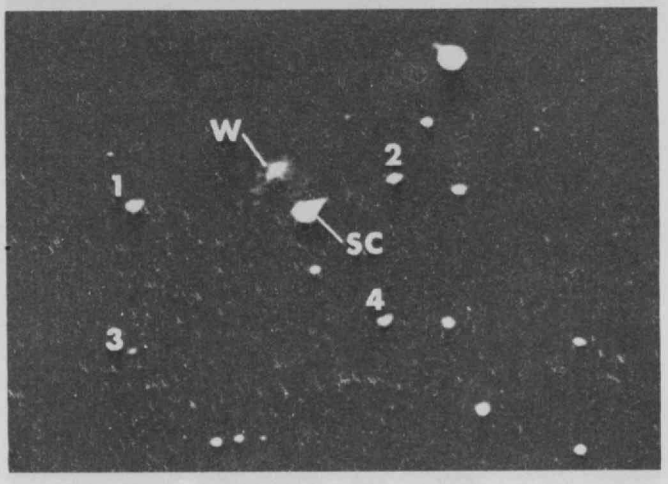
Because the launch was in the afternoon, the S-IVB oxygen dump was scheduled to occur when the eastern United States was in twilight. Working on a 7¼-inch refractor at the Amherst College Observatory that night, I looked up at the predicted time and saw—without the telescope—a bright cloud form in the vicinity of the moon. I immediately turned the small refractor towards it and saw a conical cloud with numerous flashing objects on its perimeter. Minutes later, using the 18-inch refractor, I could see a bright coma at the apex of the oxygen dump varying rapidly in brightness. Five objects surrounded the dump, some flashing very brightly.

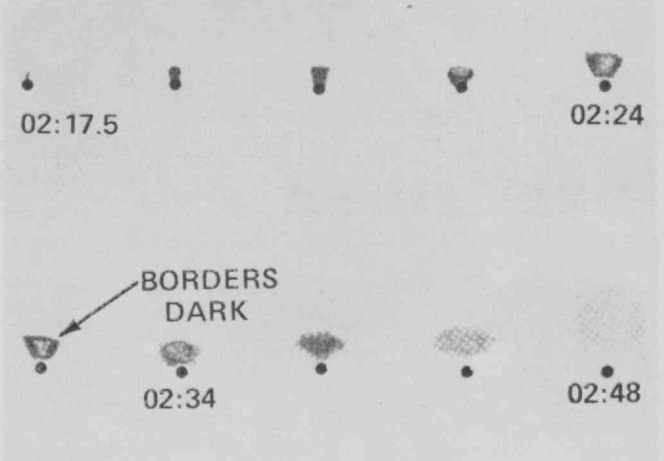
I followed this spectacular scene as it crossed the evening sky until it happened to pass directly in front of the lunar disc. The glare obscured the oxygen cloud, and the last I saw of the scene was one S.L.A. panel crossing the dark side of the lunar disc. However, two hours later, I watched a water dump from the C.S.M. and was able to follow the spacecraft and the S.L.A. panels for another three hours, until they went below the horizon. The next night, I observed the Apollo 13 and all of the

The photographs show a water dump (from Apollo 12); they were taken by Justus Dunlap at Northwestern University's Corralitos Observatory using an image-orthicon TV camera mounted to a 24-inch reflector. Visible are the spacecraft itself (SC), the water cloud (W) and the S.L.A. panels (1-4). The first picture was taken immediately after the water dump stopped, the second 25 minutes later.

The drawings (bottom), by the author, show the successive stages of a dump (Apollo 13, April 12, 1970). "Borders dark," in these "negative drawings," refers to the cloud's bright edges relative to the center. Venting stopped at 02:24, after which the cloud began to separate from the craft.

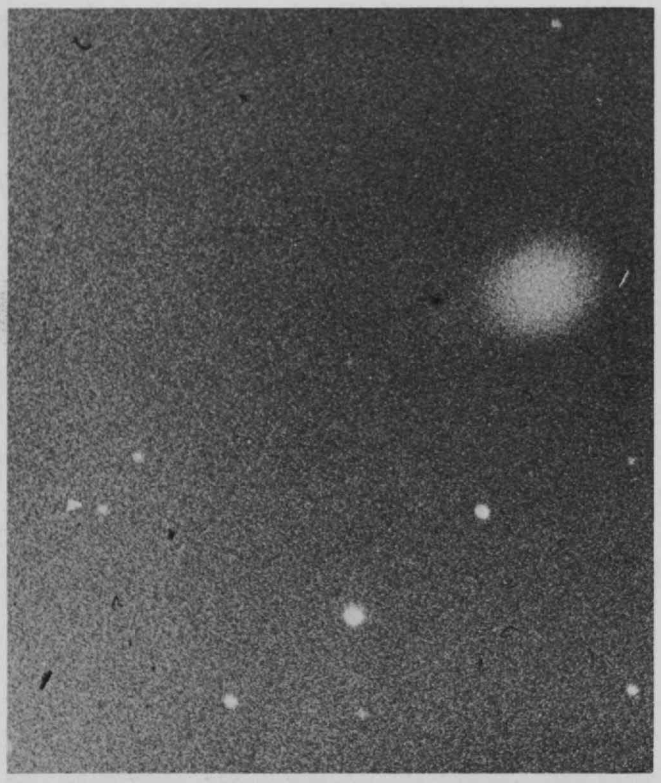


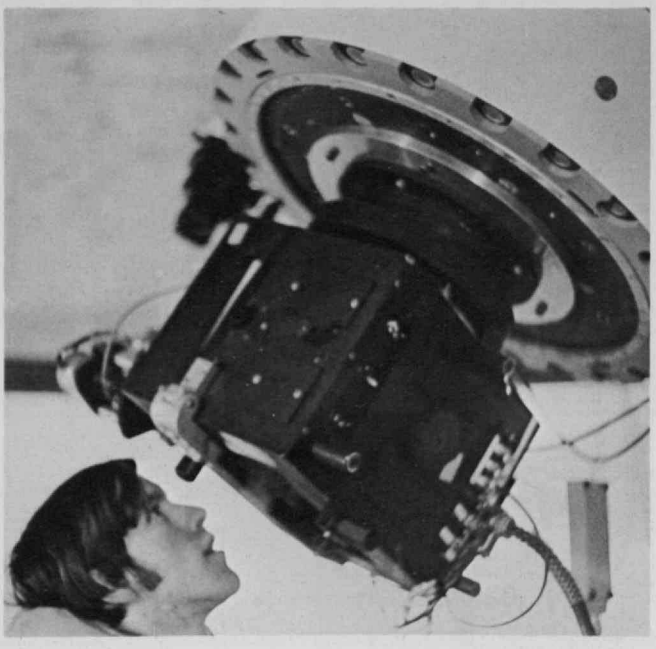




Apollo 13, two hours after the explosion, taken with a 16-inch reflector and a 15-minute exposure at Mt. Koban National Observatory, Canada. The large nebulosity on the right was not seen in previous photos.

(below) The author tests the multi-spectral photometer system mounted to the Air Force Cambridge Research Laboratory's 24-inch reflector. The extension to the left of the black box contains the phototube, which in operation is cooled by dry-ice. (Photograph: M.I.T. Planetary Astronomy Laboratory)





S.L.A. panels at a range of 240,000 km.—rather briefly, though, because the clear sky soon became overcast.

Snags and Photometry

It was on the third night of the flight that the explosion occurred. It was seen several minutes later at the Manned Spacecraft Center's Guidance and Control Observatory in Houston, on the video screen of the 16-inch reflector. The bright, nebulous patch remained at a constant brightness for about 20 seconds and then faded within a minute. Two hours after the explosion, observers around the world were telegraphed new predictions by Bellcomm Inc., and the Smithsonian Astrophysical Observatory. My own attempt to locate the spacecraft was defeated by poor weather conditions and the bright, adjacent moon, but successful sightings were made by others. These positional observations could have been used to determine Apollo 13's whereabouts if a catastrophic radio failure had occurred.

By the time of the Apollo 14 flight, I had obtained the use of a multi-spectral filter photometer developed by Professor Thomas B. McCord of M.I.T.'s Department of Earth and Planetary Sciences. The photometer is normally used to observe planetary objects. My intention was to use it to observe the Apollo 14 water dumps and its S-IVB's oxygen dumps. The photometer was mounted onto a 24-inch reflector at the Air Force Cambridge Research Laboratory, as M.I.T.'s astrophysical observatory had not yet been completed.

Since the launch was to occur in the late afternoon, the oxygen dumps and the water dumps could be observed well into the evening. As it turned out, a delay in the launch invalidated all of the computer predictions and the approximate location of the spacecraft had to be recomputed by hand. A call from Dr. Capellari and Dr. McLaughlin at Bellcom, Inc., relaying updated state-vectors later in the evening, greatly aided in the effort.

Early that night, while scanning the western horizon, I noticed an unexpected bright glowing object. The telescope showed the Apollo 14 and its S.L.A. panels surrounded by an oval cloud. Consulting a copy of the flight plan, I discovered that the cloud was a nonpropulsive venting of liquid hydrogen by the S-IVB. This event had not been observed previously from the ground.

The flight plan indicated that the C.S.M.-L.M. would move away from the S-IVB within 20 minutes. I waited for over 30 minutes and nothing occurred. This burn would have been easily visible through the telescope, and I began to suspect that something had gone wrong. Turning on a portable television, I was presented with a view of the L.M. as seen from the C.S.M., which had failed to dock. I continued to track the spacecraft, and after the docking was finally accomplished I did indeed see the C.S.M.-L.M. burn as the craft moved away from the S-IVB.

The booster then dumped liquid oxygen, which I observed using the multi-spectral photometer, making brightness-versus-time and spectral reflectivity measurements during the hour needed to dump the entire load of oxygen. High clouds and a mild case of frostbite

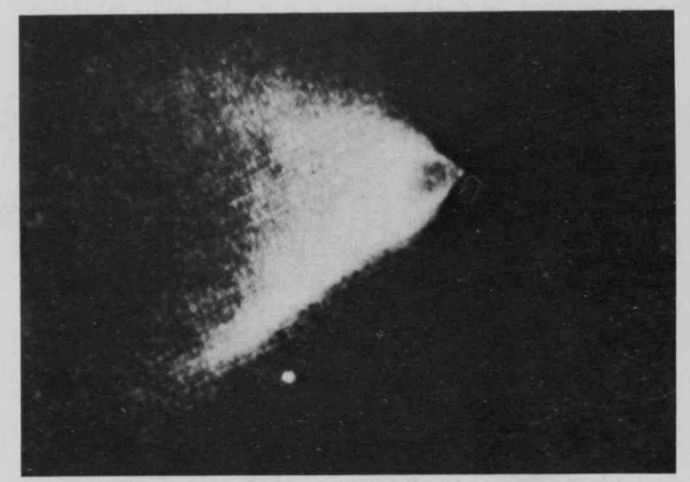
Apollo 14's S-IVB venting liquid oxygen, 65,000 km. from Earth. This dump placed the S-IVB on a trajectory towards a crash-landing on the moon, to aid seismic observations. (Photograph: Corralitos Observatory)

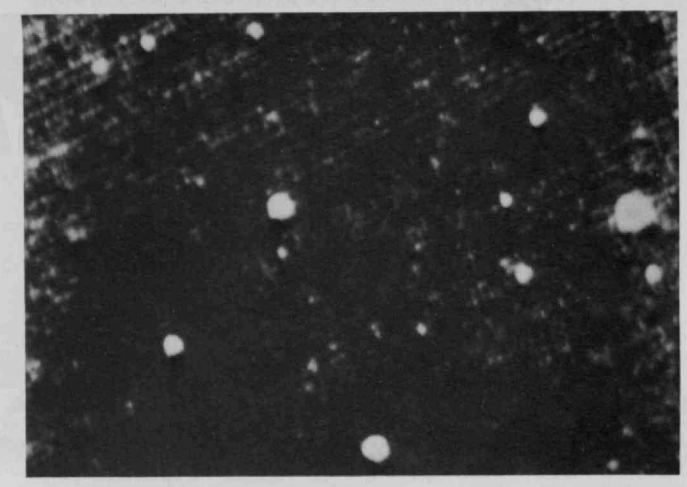
In the two lower photographs, taken nine minutes apart with a 0.5 s. exposure, Apollo 14 is seen moving slowly against the star background (from the right toward the center) at a range of 290,000 km., during its homeward journey.

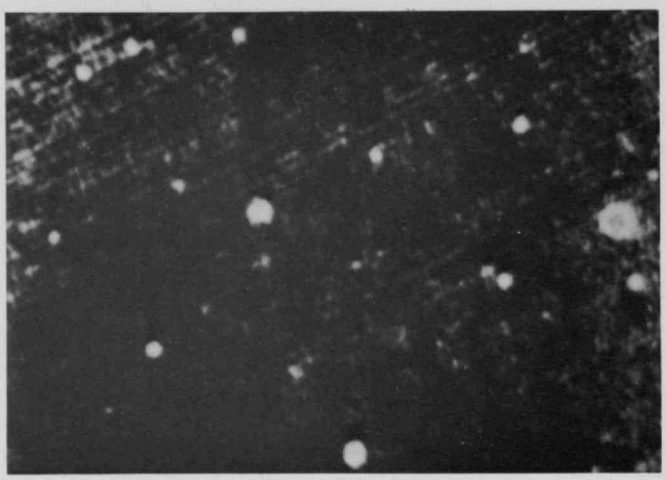
ended this session before the water dumps occurred. Attempts to observe the spacecraft during the remainder of the mission were thwarted by the malfunctioning of the telescope. However, many other observers were more fortunate, and several even viewed the C.S.M.-L.M. burn which turned the spacecraft from a free-return trajectory to a "hybrid" trajectory toward the moon. At the end of the mission, thousands of Australians and New Zealanders watched as the Apollo 14 reentered the earth's atmosphere in their evening sky.

Apollo 15, which will land in the Hadley-Apennine region of the moon, will be launched very early in the morning, so that the oxygen and water dumps will occur at midday, preventing any optical data gathering. There are at present no plans to observe any further Apollos, since the obvious scientific data has been obtained.

In looking back, I think my strongest feeling about actually seeing the Apollos going to the moon was one of awe at viewing a journey which, in Verne's words, "instead of being put off to future ages, like other so-called Quixotic projects, was now a living, accomplished fact."

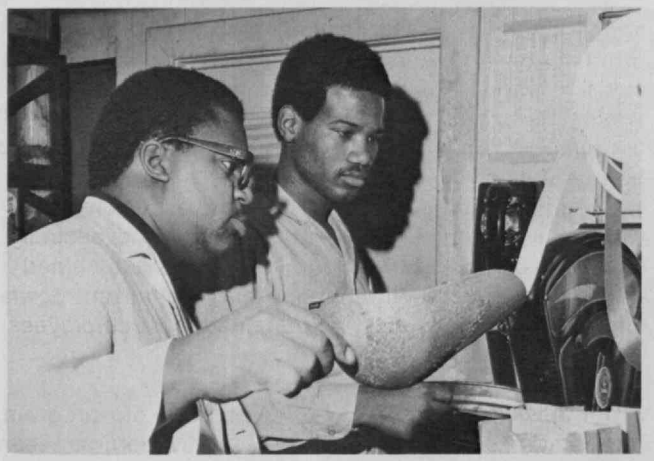


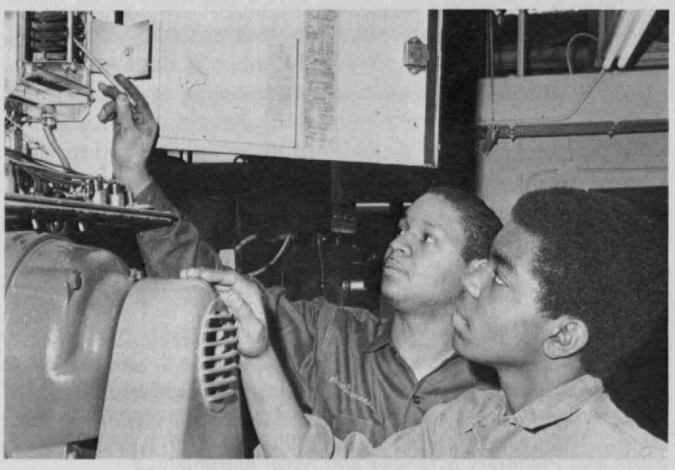




Michael P. Charette is an M.I.T. freshman. He has been actively engaged in optical satellite tracking since the age of 13, and has worked not only with North-American-Rockwell and the Smithsonian but also with the British Science Research Council. Academically, Mr. Charette's attention is divided between Earth and Planetary Sciences and Aero/Astronautics.

Running a hotel is a service business. As such, it presents special problems for management which is determined to create training and employment opportunities for minority people whose stereotype of an industrial job is subservience to the privileged.





Public responsibility—as well as selfish interest—brought this company into the National Alliance of Businessmen's program for employing the underemployed. What followed caused drastic changes in the lives of employees—old and new—and company alike

James E. Howard
Assistant to the President
for Manpower Development
Sonesta International Hotels Corporation

J.O.B.S. at Sonesta

In an effort to break the chronic cycles of unemployment and underemployment in cities, the U.S. Department of Labor released $420 million in January, 1968, for use by industry in a program organized by the National Alliance of Businessmen called Job Opportunities in the Business Sector (J.O.B.S.). The funds were to reimburse employers for the time that new employees from underemployed groups would spend in basic education and training while on the job, and for the employers' costs in providing that education and training.

Since then, most reports of activities under this program have emphasized successes and minimized failures, perhaps in order to prove that something is actually being done to ameliorate the crises of racism and poverty and perhaps because of a need to justify the expenditure of these public funds by private enterprise.

Our experience with the J.O.B.S. program in Sonesta International Hotels (formerly Hotel Corporation of America) has been kaleidoscopic, combining both success and failure. This article proposes no single view, because none can accurately tell what happened. Individuals and organizations within the corporation have gone through drastic changes. Staff morale has fluctuated widely, reflecting the fluid status of the effort. Many stories must be told by many people in order to give an adequate view of the project and its many results.

Business and Its Environment

Five major reasons explain why we in Sonesta Hotels felt the need for the N.A.B. program:

1. As a public service industry, we are acutely aware that business suffers if the social environment is unhealthy. The rebellion of blacks in Washington, D.C., in the aftermath of Dr. Martin Luther King's assassination continues to keep business soft in our nation's capital. As the gap widens between the rich and poor, the young and old, the black and white in America, the seedbed for social revolution is laid. Like nearly all corporations, Sonesta Hotels did not have blacks and other minority people in meaningful jobs and thus were contributing to the social unrest.

2. Cities are increasingly becoming the turf of blacks (and Puerto Ricans in Boston, Hartford, and New York), while affluent whites and their industries continue to flee to the suburbs. It is projected that by 1980 30 major U.S. cities will have a black majority population. The largest volume of food service and hotel business remains in the urban centers. Attracting the chronically unemployed and underemployed, many of whom are minority people, provides a new and needed labor market of individuals who reside close to our properties.

3. Employment has grown by 23 per cent in the food and lodging industry, between 1958 and 1965. Projections indicate that employment will continue to grow at the same rate through 1975, as a result of increased travel by more people with more disposable income and more leisure time. The food service industry, a prime segment of the hotel business, is the fastest growing sector of the nation's economy; its yearly growth rate is nearly 15 per cent. In May, 1968, the U.S. Employment Service reported that 65,000 food service job vacancies existed. This rapid expansion of the industry makes it clear that the number of job vacancies will increase, ultimately resulting in poor service and reduced productivity.

4. We recognize a desperate need to improve employment practices by introducing effective education, job skill training, and individualized upgrading programs. The quit-rate averages as high as 7 per cent per month in the hotel business, three times the rate of manufacturing. Employee turnover costs between $200 and $300 per person. We believe that costly and demoralizing turnover can be reduced by the addition of training staff to provide recruitment, orientation, placement, legal, medical, and other counseling support services.

5. The food and lodging industry operates on narrow profit margins. Payroll costs, if uncontrolled, can wipe out profits when production slows down. Management strategy is to maximize production and minimize payroll burden. The cycle of hiring when production is high and laying off when production goes down militates against establishing good personnel practices, especially for workers who are marginally employed. The availability of U.S. Department of Labor training funds has helped us to offset the payroll burden during the current downturn in the economy and has permitted most employees in training to retain their jobs.

Given these five reasons why we pursued the program, it becomes apparent that our prime motivation has been

enlightened self-interest. This is the most healthy and nonpaternalistic incentive to establish an honest relationship with people in need of equal opportunities that can help eliminate their economic plight.

The Needs within Sonesta Hotels

The hotel industry has traditionally suffered from a poor image in its dealing with employees in unskilled and semiskilled jobs. Entry- and lower-level jobs have frequently been dead-end. There are instances where chambermaids, housemen, and kitchen workers have been in the same job for more than 40 years. Happily, this condition is beginning to change. John F. Craver, Vice-President and General Manager of The Mayflower Hotel in Washington, D.C., was quoted early last year in the *Washington Post* as determined to eliminate dead-end jobs. "Traditionally we in the industry have placed a man in a job, dusted our hands, and said, 'Well, that problem is solved forever.' We have at The Mayflower a man who has been a lobby porter for 44 years; another man who's been an oyster shucker for 33 years; and on and on. What we have done (now) is to take a mental oath that no job will be a dead-end," he said.

A recent research report by E. F. Shelley and Co. supports this evaluation of the industry's employee advancement. For nontipped, lower-level employees, the work day has usually been long and the wage low. Jobs as warewashers, kitchen stewards, cooks, busmen, and housemen have continuous turnover. Temporary helpers, known as "casuals," are repeatedly hired at the back doors of hotels to work in the kitchen during times of peak production. Experienced cooks continue to be recruited from Europe. Outside unionized waiters and bartenders come in to serve special functions and receive excellent gratuities. Middle and upper management moves from hotel to hotel fairly regularly. Upgrading has customarily been achieved when employees, on their own initiative, transfer from one hotel to another.

Nevertheless, many people who work in hotels become deeply attached to their jobs. For doormen, bellmen, waiters, banquet managers, front desk clerks, and other service workers, caring for the needs of guests becomes ingrained as a way of life. In finer hotels, the same bell staff totes the bags of guests year after year, and for a substantial income. The glamour of hosting celebrities and dignitaries, of creating elegant banquets and parties, and generally of working in an aesthetically appealing environment gives many hotel employees a love for the business.

The national and racial composition of hotel employees is as varied as one could find in any business in the world. Coping with the multilingual and multiracial mixture of people in a hotel—both guests and employees—is a staggering challenge to a manager's human relations skills!

Early Experiences in Organizing N.A.B.

The National Alliance of Businessmen came to Sonesta Hotels when the President, Roger Sonnabend, was made New England Chairman of N.A.B. by President Lyndon Johnson. The sublime nature of that appointment is the hallmark of N.A.B.: power, transmitted from the White House to the executive suite, gave N.A.B. the birthright and the energy to do a manpower training job that the government admittedly had found difficult to do ever since the Great Depression. The old Quaker adage of "speaking truth to power" had become a reality.

The use of legitimate power is emerging as a subject for study and application in organization development. Ronald Burd examined this development in a recent Master of Science thesis submitted at M.I.T.'s Alfred P. Sloan School of Management, and he found in the Sonesta Hotels' training program a chapter of his thesis entitled, "Power to Implement Change: A Case Study." As Mr. Burd noted, power is commonly considered as negative and repressive, a "dirty word." Behavioral scientists have frequently described power relationships in strongly negative tones, often equating power with authoritarianism or machiavellianism. But in the N.A.B. effort, power was used as a force to bring about new ways of understanding people as well as to create innovative methods to hire, train, develop, and retain new employees. Indeed, Sonesta's experience demonstrates that David McClelland's power is a positive force, inextricably bound to effective managerial leadership.

The J.O.B.S. program was introduced to Sonesta Hotels by Mr. Sonnabend despite overt and covert resistance of several key people in the organization. I was responsible for designing and implementing the program and I reported directly to Mr. Sonnabend. My work included the preparation and negotiation of U.S. Department of Labor manpower training contracts.

The program within Sonesta Hotels began with the mandate to hire and train 250 unemployed and underemployed people in nine hotels and one food-processing facility in six cities over a one-year period. The first group of 32 trainees was employed in Boston in August, 1968. Three additional U.S. Department of Labor contracts have since been initiated, thereby increasing our goal to employ 360 persons by June 30, 1971. Participating units are located in Boston, Hartford, New York, Baltimore, Washington, D.C., and New Orleans.

Since nearly all of our recruits would be either black or of Spanish surname (mostly Puerto Rican), it was essential to hire black and Spanish-surname staff for training and education. Minority staff representation was also needed to provide cultural arbitration for newly hired minority employees. Most of our training staff for this project worked in a subcontract relationship, somewhat in the manner of ombudsmen, to avoid possible conflicts in the internal power structure of the organization they served.

The training staff assembled, the venture was then launched with a three-day confrontation seminar for 30 top-level executives. It was an intense confrontation, held in Roxbury, Boston's black community, during which a cross-section of blacks communicated their feelings about being systematically castrated and excluded from the mainstream of American life.

The seminar did not have a characteristic T-group

atmosphere of warmth and support. Direct confrontation with the inequities of minority group life in America was painful for all. Several managers began to feel and understand the experience that is daily lived by a black man. This seminar, as well as others which were conducted at each training installation prior to recruitment, had some polarizing effect and created resentment and confusion. Each manager was forced to work out his own personal approach and rationale toward making the N.A.B. endeavor meaningful and effective in his unit. His was a formidable challenge. He had to introduce radical organization change and at the same time confront his white staff with the reality of black demands.

From among the trainers of the original seminar, each manager selected the individual whom he desired to work in his unit as the resident staff member responsible for installing the program. Subsequently, two-day seminars were held in each unit for middle managers and line supervisors. Although some seminars were far less effective than others, time and experience have borne out that this training was the cornerstone of the entire effort. The crucial factor for the supervisor proved to be not his technical skills but his ability to develop positive interpersonal and intergroup relationships and to be aware of who his employees are; he needed to respect the humanity of all employees as human beings, not as blacks and Puerto Ricans in need of a break.

Program Results: Recruitment and Retention

From August, 1968, through December, 1970, 494 persons were hired in contract jobs. Seventy-five new employees have completed the 260 working days of training. An additional 137 persons are presently in training, giving us a retention rate of 42 per cent. Our highest loss of new hires came early in the program when we accepted applicants with very little screening and oriented groups of 20 and 30 persons at one time. The problems of placing that number of individuals into jobs at one time, we discovered, are simply too great for the resident trainer to effectively handle.

During the same period, 206 persons were hired and placed in job slots that were not included in our contracts. We sought the highest level jobs available, and when supervisors consented we placed new hires in these jobs and provided the same support services without contract reimbursement. Of these 206 new hires, 40 have completed their training, while 31 continue in training. The retention rate for persons in these noncontract jobs is 34 per cent.

Retention rates increase substantially after one and two months. An employee who stays on the job for three months is likely to remain for an appreciable period. I am dubious of published figures indicating retention rates of over 50 per cent for all new hires from day one until the completion of the training period. Low retention rates should not be surprising, given the general profile of people who have been hired under the program: more than 80 per cent lack a high school diploma; most trainees range in age from 21 to 28; most lack marketable job skills; many blacks and Puerto Ricans have come from plantation systems with a master-slave work relationship; many come from homes ridden with domestic problems; for many, the most recent work experiences have been in sweat shops with dictatorial bosses; many lack self-confidence and the political knowhow to improve their lot; and their initiative has been destroyed by discrimination and discouragement in the absence of honest brokers who truly care for their well-being.

Under traditional circumstances an employee will simply leave the company when he cannot make it in his original job. But when an N.A.B. trainee is dissatisfied with his job for a valid reason, we insist that our resident trainer look for job transfer opportunities. Our retention rate at The Plaza Hotel in New York has averaged nearly 50 per cent due to effective transfers.

The N.A.B. program has sought to build a job around a man, in contrast to the normal procedure of finding a man to fill the job. When a 42-year old man entered the program at our food manufacturing facility in Baltimore, we discovered that during the previous eight years in prison he had developed excellent skills in the graphic arts. The trainer helped to create a new job around this man's skills—designing and silk screening of food can labels and posters—and the man was enabled to work at a meaningful job. At the same time, HCA Foods saved money by doing its own graphic art work internally instead of contracting it out to an advertising firm.

Education Programs

Nearly all trainees participate in tutorial or classroom education. In every unit classroom instruction is open to all employees who lack a high school diploma or desire to learn English as a second language. To date 49 employees have passed the general education test required to earn the high school equivalency. Learning has required more time than we anticipated, since employee/students turn out to be seriously deficient in reading, writing, and other basic education requirements. At present, 225 employees receive instruction at least twice weekly. Permanent classrooms have been set up. The teaching staff has learned to continuously adapt curricula to individual employee needs and to constantly relate learning to the job, whether the job be in accounting, office work, cooking, or engineering.

Since classes are conducted during working hours, the teachers need cooperation from department heads and supervisors. The underlying attitude of management is often revealed at this point. The response has been mixed, with some supervisors adjusting schedules to accommodate employees and others using this opportunity to sabotage their employees and the program. At the Royal Sonesta Hotel in New Orleans, nine managers and supervisors join the teacher in conducting classes in the areas of their job specialty; this appears to be an effective counteraction to the problem of noncooperation. In all, 180 employees, out of a total work force of 400 at the Royal Sonesta, enrolled in such courses as shorthand, typing, bookkeeping, math, English as a second language, culinary arts, and business machine operations.

Some beautiful achievements have occurred in the education area. One teacher in Boston included the following comment in her monthly report for September, 1969: "Class days were sprinkled with memorable achievements such as a sixty-year-old woman's success in writing her name for the first time in her life. Another student came to the hotel for class three times during his week of vacation. A third young man consistently comes to work an hour early so that he will have additional time to attend class."

Secondary Effects of N.A.B. Activities

The most exciting aspect of the program has been its broad impact upon general employment practices. What began as a "program" soon became a process that had a catalytic effect upon the attitudes and practices of management with respect to all employees.

We believe that these secondary effects are visible: In varying degrees, the system of hiring, orienting, training, motivating, and retaining has been improved. Employees often seem more aware of human relations factors in daily operations. Many employees under the program have been promoted, and this has been tangible evidence of the value of implementing career ladders and job alternatives; following the human relations seminars at The Mayflower Hotel, 14 black employees were promoted. Orientation and education programs have been installed on a permanent basis for new and regular employees alike. Wage increases have been forced upon some reluctant managers and these have helped to improve recruitment and retention. Vital new jobs, such as those of trainers, teachers, and job counselors, have been created. And a new sense of social responsibility has been achieved throughout the organization. The Sonesta Human Development Fund has been organized to evaluate all corporate contributions and to invest up to 5 per cent of annual pre-tax profits in socially useful projects such as scholarships, credit unions, and day-care services to benefit low-income employees.

What Sonesta Has Learned

We have learned many things about people and organizations in more than two years of N.A.B. activity. We have learned, for example, that white racism is the fundamental problem. Racist attitudes manifest themselves in the form of exclusion, segregation, condescension, paternalism and double standards, all of which place an almost intolerable burden upon minority persons who are nearly powerless in an alien and sometimes hostile work environment. For example, certain jobs are controlled from within a department. We have in our hotels several specialty restaurants that are run by one ethnic group or another. A new waiter is hired by department employees, and the Personnel Department is not informed of the job vacancy until it has been filled by a member of the controlling ethnic group. A few managers are slowly beginning to break down this divisive hiring system which is racist in nature.

While it is true that white racism is the fundamental problem, it should be added that the quality of supervision is closely coupled with this problem. We have found that a supervisor who does poorly with all of his subordinates has had special problems with trainees, whether he is overtly bigoted or not. On the other hand, our good supervisors have tended to be successful in training people whether bigoted or not. For this reason we have now begun to emphasize general supervisory training, rather than training that relates to the specific requirements of trainees.

We have learned that change can occur only if legitimate power comes from both inside and outside the organization. Government support was essential. But Roger Sonnabend's unswerving commitment was the *sine qua non* of any achievement we have gained. Many managers were ready to rationalize failures or to sit back and wait to respond to the next demand. These negative attitudes were effectively countered by positive support from the top of the organization.

We have learned that leadership must be by blacks, if blacks are to be the prime recipients of the effort. Resident trainers are frequently approached by employees with complaints about supervisory treatment, requests for help in locating apartments or loans, and job transfers. The trainers interface every day with employees at their work sites. They serve as honest brokers to employees who are often relegated to the bottom levels of the pecking order.

We have learned that supervisory training must be a continuous process. The supervisor has the power to influence any advancement his subordinate might enjoy. We have documented several cases of employees who were able to upgrade themselves from reservation clerk to reservation manager, or from store-room clerk to purchasing agent, for example, because the supervisor desired these promotions. In instances where an employee was deficient in a job skill such as typing or mathematics, supervisors have arranged with the employee and the teacher to develop the necessary skill. Examples of this kind are pitifully few, but they have demonstrated the importance of the supervisor in upgrading.

We have learned that a company must be prepared to do its own follow-through on human relations training, recruitment, orientation, and support services. Government and community agencies can offer limited technical assistance. Competent and experienced individuals employed on a consulting or subcontract basis

can achieve far more than staff who are paid by outside organizations or merely volunteer their services.

We have learned that programs designed specifically for one group of individuals are more effective if they are generally applied to all employees. We have tried to avoid developing a class of special-privileged employees which would heap more prejudice on trainees. Our most successful training component in which all employees are integrated is education. A European *sous chef,* a Puerto Rican houseman, a Cuban accounting clerk, and a Portuguese chambermaid are likely to attend the same English language class. At the Plaza Hotel, a black woman is employed as a job counselor. She posts job openings on a daily basis in the employees' cafeteria so that any employee seeking a better job can apply. Applicants are referred to the appropriate supervisors who cooperate with the personnel department to transfer an employee or give assistance that will lead to upgrading opportunities. Furthermore, we have learned to discourage the use of insensitive descriptive terms such as "hard-core," disadvantaged, or underprivileged, which alienate employees even more and serve to identify them as members of a special race or class.

We have learned that no amount of training and education can substitute for the material reward of jobs with status, challenge, and a decent income. Jobs with an hourly rate of less than $2 are unrealistic. Most of our staff will not hire people in jobs paying under $2.

My reference to the $2 hourly rate as a realistic minimum wage for trainees applies primarily to our northern cities. We believe that people in New Orleans, for example, have had important opportunities but entered employment in jobs paying less than $2. Of course, no one earned less than the federal minimum wage of $1.60.

The importance of making a wage increase after three or six months of employment cannot be exaggerated. When supervisors resist making wage increases for trainees who are performing satisfactorily, and the trainees are working in lower-level and lower-wage jobs, those trainees tend to leave.

We have found that training is most effective with women and men over age 26; that older women will probably make good hotel employees whether they are trained or not; that training for younger men will probably only hasten their departure into other fields; that people who are motivated by a "need" to serve or who feel rewarded from "helping" relationships are most likely to succeed. In HCA Foods, which is a manufacturing unit, we have had good luck with people in white-collar jobs such as clerical and computer operators, and with women in production jobs. Young men tend to leave assembly-line production jobs after three or four months.

We have learned that if the current Equal Employment Opportunity report does not show a fair number of minority employees in middle and upper categories, programs such as the N.A.B. are short-lived. We see a correlation between good results in the N.A.B. effort and the equal employment practices of each of our units. The credibility of any training and upgrading program can be measured by the composition of people now in middle- and top-level jobs.

The Responsibility of the Corporation

After two and a half years of conducting the N.A.B. program, we sense that ownership of the program is now more widely distributed throughout the units of the Sonesta International Hotels. Benefits and services to employees that accrued around this effort are more or less available throughout the work force. Nomenclature such as "N.A.B." is fading out, while the content of the program has become an integral part of employment practices.

The National Alliance of Businessmen grew in the aftermath of city riots when government had to pressure the private sector into opening job opportunities for minority people in the 50 largest U.S. cities. Business responded positively, particularly in the automobile industry (Henry Ford II was the first N.A.B. Chairman) and among large defense contractors.

As conditions in the cities reverted to "normal" and the present economic recession set in, with most companies laying people off or at least putting a freeze on hiring, we see the N.A.B. losing its thrust. The Department of Labor has sharply lowered its expectations for the program, and instead has doubled the funds for the Public Service Careers Program to $132 million (86,900 new jobs.) We sense that this action reflects the government's conclusion that programs such as Plans for Progress, Equal Employment Opportunity, Office of Minority Business Enterprise and the N.A.B. do not find in industry the depth of commitment or the widespread support required to change income patterns and to root out racism. But we remain certain that the primary mission of the corporation in the 1970's must be to help in building a just society in a socially responsible way by learning to give as much attention to human needs and values as it does to profits.

James E. Howard came to Sonesta (then Hotel Corporation of America) when its President, Roger P. Sonnabend (M.I.T. Class of 1946) resolved on an aggressive program of new opportunities for minority-group job candidates. He studied at Franklin and Marshall College and Drew University (M.A. in psychology and theology, 1960) and was associated with the Philadelphia Methodist Conference and the American Friends Service Committee (as College Program Director in Cambridge) before joining Sonesta, and he is now in charge of training for the company's new hotel in Nassau, the Bahamas.

Today's controversies over the location and management of nuclear power facilities (below: the nearly completed Pilgrim Station of Boston Edison Co. near Plymouth, Mass.) make abundantly clear the need for innovative, interdisciplinary techniques of assessment. The authors propose a plan for mounting such an effort. (Photo: New England Aerial Surveys from Boston Edison Co.)

Unemployed engineers, whose experience at problem solving can surely be generalized, might profitably be put to work by Congress in independent laboratories dedicated to environmental assessment

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Manpower for Environmental Action: A Proposal

A year ago, the National Environmental Policy Act (N.E.P.A.) was signed by the President and became effective. This law is an extraordinary attempt, indeed a noble one, to bring our industrial society into closer harmony with nature, to alleviate present environmental problems and to avoid future ones.

N.E.P.A. is brief. It contains some broad national policy statements and environmental objectives, but it also calls for immediate and pragmatic actions by all agencies and offices of the federal government. Essentially, these actions are interdisciplinary assessments of federal operations and decisions as they relate to environmental quality, and they are now the responsibility of all agencies, from the Atomic Energy Commission to the Securities and Exchange Commission.

Implementation of N.E.P.A. has been unsatisfactory this first year. There are a number of reasons, and a major one, the shortage of skilled environmentalists, stands out in sharp contrast to the growing numbers of unemployed scientists and engineers who could play a significant role in the fulfillment of N.E.P.A. objectives. This condition deserves immediate congressional attention.

What the Act Requires

Environmental problems are complex and deeply rooted in our values and culture. The recent flurry of environmental activity in the Congress has produced a number of new laws and federal officials. However, it is clear that there are no simple solutions, and that we will have to grapple with these problems on a sustained basis.

N.E.P.A. appears to be the most significant of these new laws, and the executive office created by N.E.P.A., the Council on Environmental Quality (C.E.Q.) has become the federal conscience on the environment. N.E.P.A. is significant because it is the most coherent federal statement of environmental values and objectives, and because it calls on federal agencies and offices to develop new decision-making processes or habits to implement these values and objectives.

The new decision-making processes are required for "major federal actions significantly affecting the quality of the human environment. . . ." This is certainly an ambiguous beginning, but "major federal actions" are believed to include such functions as approval of funding for major transportation or construction projects, licensing of power plant construction or operation, major procurements, agency proposals for legislation, and leases of federal property for extraction of mineral resources.

A detailed statement of the decision-making process must be submitted to the Council before each "major federal action" officially occurs. N.E.P.A. is not explicit on what happens next, but C.E.Q. has assumed the review of substantive and procedural aspects of the decision-making process contained in the statement. C.E.Q. disapproval results in negotiation with the federal agency or office which seeks to act, to modify certain aspects of the proposed action in the interests of environmental quality. This is now happening.

This review procedure and the emerging role of C.E.Q. are full of unanswered questions at present, and effectiveness will be determined by the influence the President chooses to exert in specific cases, and by the moral and financial support he and Congress provide the Council and its enforcement arm, the new Environmental Protection Agency. Finally, effectiveness will be highly dependent on the breadth and quality of the decision-making process which assesses the environmental effects of each proposed "major federal action."

Now, to turn to the nature of this process imposed on federal agencies and offices. N.E.P.A. calls for their a priori assessment of the environmental impact of each proposed major action; determination of unavoidable adverse effects on the environment and of irreversible and irretrievable commitments of resources if the proposed action is implemented; comparison of the short-term environmental use proposed with long-term needs; and an analysis of alternatives to the proposed action.

In addition, N.E.P.A. calls for the use of interdisciplinary assessment teams, consultation with other federal agencies and offices with relevant expertise, and consideration of all environmental amenities, whether or not quantifiable. Economic and technological factors are of course quantifiable, and have been the basis for most federal actions. Now, somewhat quantifiable factors such as physical and mental health, and unquantifiable factors such as aesthetic and cultural considerations must be included in the process of decision making.

State agencies, legislatures, and pollution control boards have started to follow this N.E.P.A. approach to a priori assessment of environmental impacts, so that non-federally funded projects are also coming under broader scrutiny

Can Assessment Now Be Objective?

N.E.P.A. certainly imposes a substantial burden on federal agencies. Many agencies reflect a particular disciplinary character (e.g., the Atomic Energy Commission), and normally grapple with familiar quantifiable considerations only. Agency personnel, procedures, values, and skills are largely inadequate for these new tasks.

Nevertheless, some agencies have hired new personnel, redesignated functions, revised operating procedures and regulations, sought to meet N.E.P.A. requirements, and have submitted required statements to C.E.Q. Other agencies have been laggard in developing impact statements, have sought additional funds and time to implement these requirements, and have disparaged and even resisted compliance. A deputy secretary of the Department of Housing and Urban Development, in testimony before the House Merchant Marine Subcommittee on how N.E.P.A. is being carried out, has suggested a "halt in the environmental numbers game . . . we are in danger of creating a bureaucracy of professional statement writers and readers as well as encouraging a parasitic consulting agency to thrive on the business of environmental statement preparation" *(Environmental Reporter,* Vol. 1, No. 35, p. 891 [December 25, 1970]).

Probably the most serious N.E.P.A. implementation problem concerns the matter of *objectivity* in the assessment of environmental impact. Our public and private institutions, professional associations and peer groups, have consistently exhibited the ability to ignore environmental implications of the programs they wish to carry out. The federal agencies now charged with N.E.P.A.'s objective assessment responsibilities long ago developed values and objectives in common with constituent industries, peer groups, and professionals. Federal and state agency standards and regulatory procedures derived from these conditions are now seen to be in conflict with N.E.P.A. purposes. Additionally, the derivative processes of standard setting and enforcement have long been effectively insulated from citizen participation.

The *New York Times* recently reported that: "Most of the state boards primarily responsible for cleaning up the nation's air and water are markedly weighted with representatives of the principal sources of pollution . . . a nationwide investigation by the *New York Times* . . . revealed that membership of air and water pollution boards in 35 states is dotted with industrial, agricultural, municipal, and county representatives whose own organizations or spheres of activity are in many cases in the forefront of pollution. . . . The widespread practice is . . . defended by those involved on two grounds. One is that such individuals bring to bear needed expertise and familiarity with pollution problems. The other is that such entities as industry, agriculture, and local government, because of their civic importance, rate special consideration. . . . Although there is no precise way to measure the impact of such boards on pollution problems . . . there is abundant circumstantial evidence that they do not expedite pollution abatement" (December 7, 1970, p. 1). This situation, flagrant at the state level, is less obvious at the federal level, where representation of interests is not personal, but just as effectively manifests itself in shared values and compatible regulatory procedures.

Yet Objectivity Is Imperative

Objectivity in environmental decision making is necessary for N.E.P.A. to bring about its social goals. William Ruckelshaus, head of the new Environmental Protection Agency, recently told the 50 state governors that: "State pollution boards are the most important regulatory agencies currently in existence to protect the quality of the environment. It is imperative that the men and women who sit on those boards—and who are empowered to set and implement reasonable standards of pollution abatement—be influenced only by the general public interest and not by any vested interests. The credibility of our efforts at every level to restore environmental conditions rests on our ability to pursue a rigorously independent course toward a clean and healthy environment" (*New York Times,* December 15, 1970). In light of the evidence, objectivity cannot be expected to flourish inside the agency-industry-peer group system. Provision must be made now for the appropriate context for objectivity—for the establishment of independent institutions and careers for environmental analysts.

Another major N.E.P.A. implementation problem con-

cerns the manpower required to perform environmental assessments. There are few who would call themselves environmentalists in a professional sense today, and it is clear that most of our disciplinary programs of higher education have not provided today's professionals with appropriate training for environmental assessment functions. Academic programs are rapidly changing, but a major difficulty remains: environmental problems are interdisciplinary, whereas most academic departments do not encourage or reward students and faculty who extend their research and teaching beyond disciplinary confines. There are few environmental assessment experts as a result.

N.E.P.A.'s requirement for interdisciplinary analysis is based on an understanding of the nature of our environmental problems; yet it is unrealistic in terms of federal or state agency resources. The work to be done will clearly require multidisciplinary teams of skilled professionals capable of relating and structuring information, ideas, and values from many fields who can apply the resulting syntheses to specific cases.

No public agencies possess individuals from all the relevant disciplines—e.g., mental health, American history, aesthetics, ecology, public health, economics, systems analysis, sociology, among others—which would be needed to develop complete assessments in many cases. Assembling and training such teams will be a time-consuming and expensive undertaking for each agency, and it seems doubtful on a cost-benefit basis that each agency can or should be allowed to develop this full array of resources. Finally, such resources would, of course, be dependent on the agency and its constituents for career advancement, and it is likely that objectivity would be inhibited as a result.

There are other significant issues that will have to be resolved appropriately, for N.E.P.A. to bring about an effective modus operandi to ensure environmental quality. These include enforcement, public access to environmental assessment studies by means of the Freedom of Information Act, adequate staff and funds for C.E.Q. and E.P.A., and, of course, the interpretations which await N.E.P.A. in the courts. Nevertheless, two basic problems, objectivity and manpower, can be resolved to a considerable degree by congressional action in a manner which also utilizes the growing numbers of unemployed scientists and engineers resulting from defense and aerospace cutbacks.

A Ready Supply of Professionals

By the end of 1970, "estimates put the number of unemployed scientists and engineers in the nation at 45,000" (*Science* 170:1384). Most have had extensive experience in aerospace and defense work, or in fields such as high-energy physics, and represent a national resource of skilled manpower.

This national resource has been developed with considerable government funding. As the *Science* article added: "The plight of the unemployed (aerospace and defense) professional is intrinsically no more painful than that of the jobless clerk or production worker. . . . But in one respect the professional is different. His education and development in his profession in a real sense represent a national investment . . . there can be little argument that the talents of unemployed aerospace and electronics professionals constitute a national resource which is largely going to waste. By and large there are no mechanisms to use their talents to help solve environmental and social problems."

Several mechanisms have been proposed, but appear deficient in a number of respects, particularly in their disregard for national environmental needs. The Manpower Training Development Program of the Department of Labor has allocated $28 million to several states for upgrading and retraining unskilled and semiskilled workers. It is expected that such funds will continue to assist subprofessionals but offer little help to scientists and engineers, and no discernible help for environmental decision making. H.U.D.'s Model Cities program is expected to implement a program for retraining unemployed professionals to work on urban problems, but details are not available. Urban problems provide a narrow subset of our broader environmental problems, and an urban focus would, while important, appear to limit the program's potential for meeting environmental needs.

Recent hearings of the Subcommittee on Conservation and Natural Resources of the House Government Operations Committee elicited several suggestions. These included the opening up of government research programs treating the environment to industrial firms, in order to create new jobs; and the awarding of environmental project-definition contracts to aerospace firms because of their systems-analysis capability. Neither plan would guarantee the objective assessment vital to environmental problem solving. Ralph Nader's proposal to establish new professional standards for employees by congressional legislation, to enhance and safeguard their right to dissent from employer or sponsor policy, would help to bring about a social role for individual scientists and engineers. But pragmatic considerations of job change and career advancement would appear to limit the potential of this approach alone for environmental and other public purposes.

A Proposal for Congress

A coherent approach for mobilizing our resources of unemployed professionals to work on environmental

problems and improve decision-making processes established by Congress' National Environmental Policy Act, should include the following steps:

◊ Congress should authorize and fund the establishment of a number of nonprofit Environmental Assessment Institutes (E.A.I.'s).

◊ These institutes should be staffed by presently unemployed scientists and engineers who seek to work on environmental analysis in an interdisciplinary, problem-oriented context.

◊ Curricula and training programs should be established at neighboring academic institutions, to provide formal ongoing training programs to E.A.I. staff.

◊ E.A.I. personnel should be supplemented with professionals and faculty from other disciplines—for example, public health, aesthetics, history, conservation, law, and the social sciences—to provide a complete interdisciplinary approach to specific environmental problems.

◊ Professional status should be accorded E.A.I. staff, after participation and training criteria have been established and accomplished.

◊ Use of E.A.I.'s should be built into the federal procurement process. For example, on major federal procurements, contract provisions should require that government contractors subcontract the environmental assessment responsibilities to an E.A.I. The resulting environmental assessment would be provided the federal agency prior to the determination to proceed with a program's implementation. Use of an E.A.I. would be a contract award condition.

◊ Selection of an E.A.I. could be on a random basis to prevent industry from selecting an E.A.I. on the basis of anticipated results, and to inhibit E.A.I.'s from seeking subcontract work by developing a reputation for pleasing the prime contractor. Present small business subcontracting programs of major government contractors provide a partially analogous experience.

◊ The resulting agency-E.A.I. relationship would be established for sensible periods of 12 to 18 months, during which the E.A.I. would serve as an independent and necessary consultant to an agency on all its major decisions. E.A.I. reports would accompany those of the agency to the Council on Environmental Quality.

◊ State and local government use of E.A.I.'s should be encouraged, and required if federal funds are involved.

◊ E.A.I. reports should, upon completion, become public information. The significance of the E.A.I imprimatur on environmental assessments, its objectivity and interdisciplinary nature, will be recognized by the courts, legislatures, and other social decision makers.

The program presented here for congressional consideration could serve to develop the environmental assessment skills presently in short supply, and to guarantee continuing objectivity by developing independent career patterns. Within each E.A.I., pressures would be large and continuous for the evolution and development of environmental assessment methodologies that transcend the specific problems encountered. The experience of space and defense professionals with the analysis, study, and control of complex physical systems could then be transferred with high utility to broader environmental systems.

Conversion Ought to Be Possible

Environmental assessment involves a dimension of interdisciplinary coordination and effort rarely achieved to date. The most successful example of functional interdisciplinary work in recent years is the space program, in which scientists and engineers have, on a smaller scale free of value conflicts, solved a limited environmental problem: they have created through an interdisciplinary effort a complex system in which a few highly trained astronauts have lived safely for several days and accomplished discrete objectives. The relevance of their skills to our environmental assessment needs seems to have been demonstrated clearly in the Apollo program. To a lesser extent, weapons systems and deep-sea programs exhibit similar relevance. Bringing ecological balance to the nation is a much more complex problem, involving all life, competing values, and rapid rates of change in population, consumption, and desired health levels. Nevertheless, space and defense professionals have had relevant experience in planning and implementing smaller-scale programs.

As scientists and engineers work closely with specialists from other disciplines on environmental problems, innovative systems techniques of environmental assessment and ideas for the applications of technology will be developed. Substantial public savings will be effected, since the numerous state, local, and federal agencies would not have to expend considerable funds and time to develop in-house assessment groups or deal with environmental problems on an ad hoc basis. The true savings would accrue to the nation.

Efforts to preserve and enhance environmental conditions through a coherent and pragmatic program can be made coincident with efforts to utilize fully our skilled human resources. Hopefully, Congress will understand and act.

Mr. Baram is presently a codirector of the Center for Law and Health Sciences, a cooperative group formed by Boston University, Harvard, Tufts, and M.I.T.; he is also an Associate Professor of Civil Engineering at M.I.T. Having studied engineering at Tufts (B.S.) and law at Columbia (L.L.B.), he centers his teaching on environmental law and the social control of technology.

Dr. Barney met Mr. Baram last year in the course of postdoctoral work on urban and environmental problems at M.I.T. He returned this year to a position as staff analyst at the Center for Naval Analyses, affiliated with the University of Rochester, where he hopes to begin research in these areas. He holds a doctorate from the University of Wisconsin for work in controlled fusion research.

Trend of Affairs

Dynamic Cooling

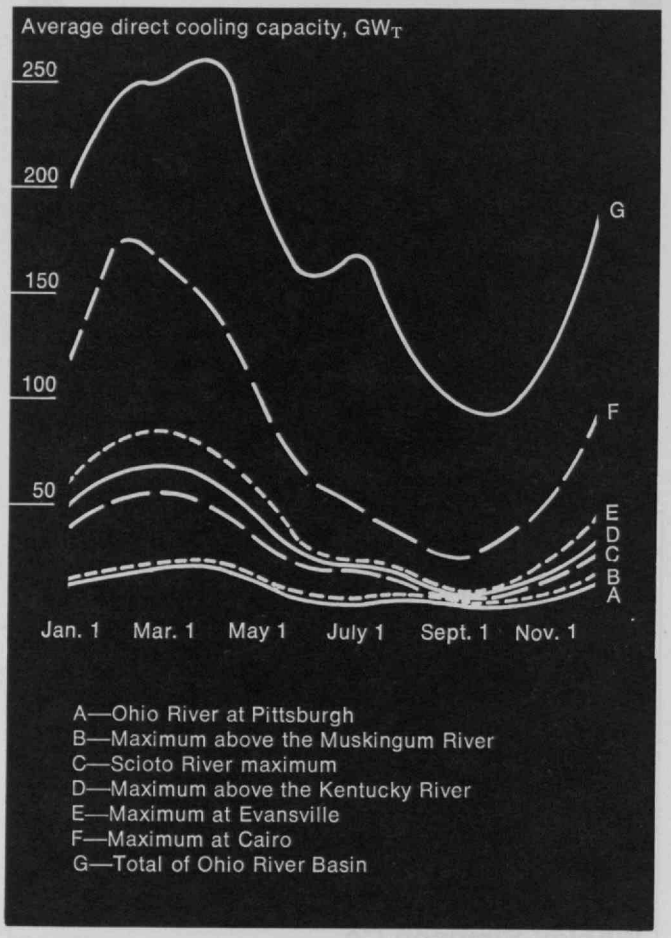
Sometime between 1984 and 1990, the cooling capacity of the streams which comprise the Ohio River Basin will be exceeded by the thermal loads to be placed on them by conventional operation of electric power generators. What then?

This prediction is the result of testing an elaborate computer program called COLHEAT, produced by the Pacific Northwest Laboratories of Battelle Memorial Institute to determine a river's cooling capacity in relation to any set of stream standards which may be chosen. The program has obvious importance for those who are concerned with siting new power facilities, and the Battelle engineers believe it also suggests how cooling facilities may be managed in a dynamic mode—in contrast to today's rigid practices—to increase the capacity of many watersheds.

For its test of COLHEAT in the Ohio River Basin, Battelle's standard was that quantity of heat which could be assimilated by any stream and then dissipated to the atmosphere within a stream temperature envelope of 5°F. above background. On this basis, the cooling capacity of principal streams in the Ohio River Basin varies markedly over the year (*see chart*), depending on seasonal variations in the amount of flow.

Using Federal Power Commission estimates of a 6 per cent annual increase in power generation through the decade of the 1980's in the area, Battelle's COLHEAT shows that power demand in the Allegheny River watershed will exceed that river's cooling capacity in the two low-water months of the year by 1980. Similar conditions exist on the Kanawha and Wabash Rivers. The Monongahela River's limit is farther away, but the Muskingum River "cannot attenuate present loads and remain with a 5°F. temperature differential during September and October." For the Ohio River as a whole, there is "considerable additional cooling capability" below Evansville, and some sections of the upper Ohio—as between Huntington, W. Va., and Cincinnati—also have ample capacity.

D. E. Peterson and R. T. Jaske of Battelle believe their results confirm that COLHEAT will be useful in two ways: to locate areas in a watershed where additional generating capacity can safely be added using only river water for cooling; and to demonstrate how modest supplementary cooling facilities operated on a seasonal basis can make possible marked increases in capacity.

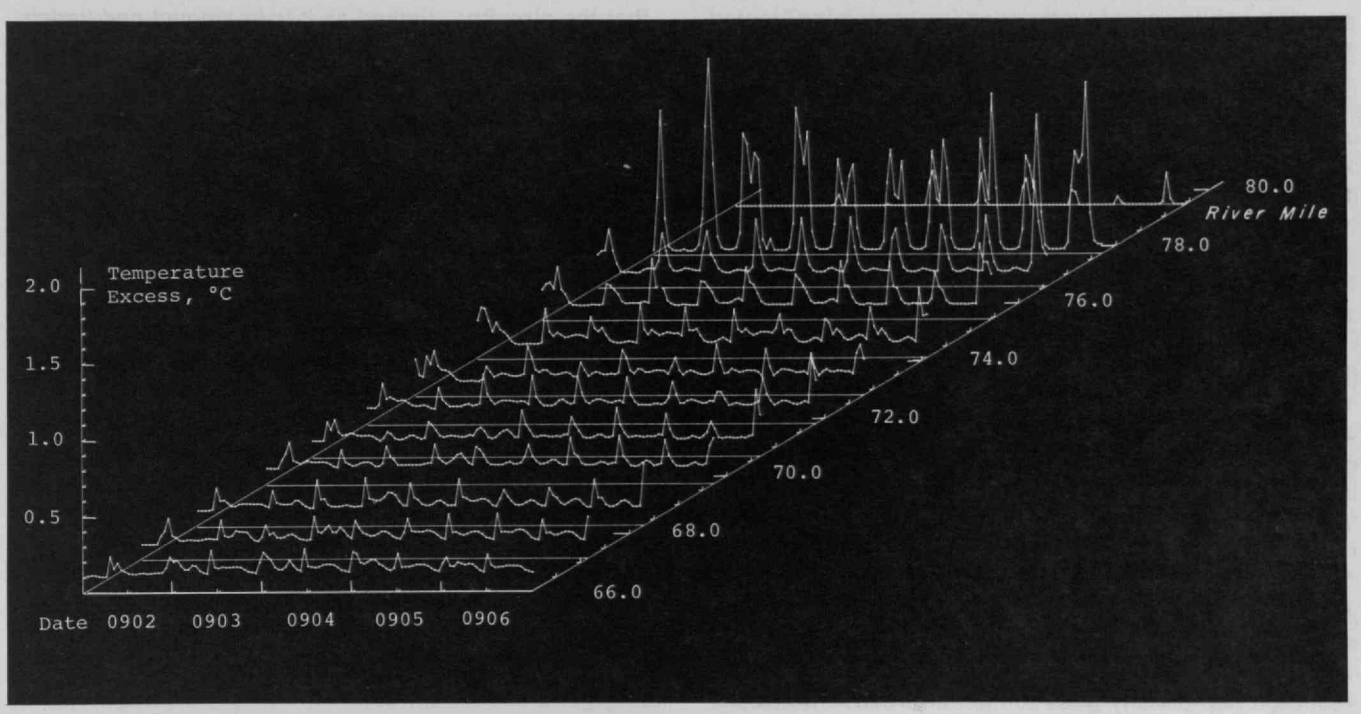


Such a supplementary facility might be a pond in which heated water could be stored in September and October for release during the winter—and which in other seasons would serve as a recreational resource; or a cooling tower to be used only when river cooling capacity was inadequate. Such arrangements operated on a seasonal basis would make possible a fourfold increase in generating capacity along the Ohio River within the constraints of their test, say Messrs. Peterson and Jaske.

In earlier work, Dr. Jaske and a number of colleagues

The thermal capacity of the Ohio River Basin (left) varies with natural flow, with lowest capacity at periods of lowest water. In ten months of the year, say D. E. Peterson and R. T. Jaske of Battelle Memorial Institute using their new COLHEAT computer program, there is sufficient cooling capacity "for most of the forecasted power needs through the end of the century." Expensive auxiliary cooling would be required only during two or three months; and COLHEAT provides an estimate of the amount and duration of these needs.

COLHEAT, the computer program first used at Battelle Memorial Institute's Pacific Northwest Laboratories to determine the heat capacity of the Ohio River Basin, has been modified to study as well the heat capacity of an estuary in which tides modulate the fresh water stream flow. The result is this kind of three-dimensional chart: in this case, COLHEAT shows the temperature excess in a portion of the lower Columbia River estuary between mile 66 and mile 80 (St. Helens, Ore., is at river mile 86) which would be caused in weather typical of early September by a 1000-MW. nuclear generating plant cooled with river water at mile 78.



have proposed large-scale modifications of water systems to increase their heat capacity (*see* Technology Review *for July/August, 1970, pp. 58-59*). COLHEAT would obviously be an essential partner in such planning.

Pollution: Chemists Refine Their Position

In the fall of 1969 the American Chemical Society published *Cleaning Our Environment—The Chemical Basis for Action,* a 250-page book containing 73 recommendations. The President's Science Advisory Committee, in the Churchillian tradition of wanting everything on one sheet of paper, encouraged the A.C.S. to produce a shorter list, with priorities and with suggestions as to who should do what. The resulting *Supplement* has 20 pages and 26 recommendations.

The Society sticks to the original "four overriding themes," which seem worth quoting verbatim:

◇ "The vast amount of existing knowledge that can be applied today, given the will and the money.

◇ "The primitive condition of our fundamental knowledge of how living things are affected by long-term, low-level exposure to contaminants.

◇ "The inadequacy of many analytical chemical methods used to monitor, control, and study the environment and the related phenomena.

◇ "The lack of data adequate to allow us to define normal trends in the concentration of the contaminants in the environment, to define deviations from normal trends, and to design valid models for subsystems of the environment."

But there is now a fifth overriding theme—lack of manpower, mainly due to inadequate government funding. "In air pollution control alone, manpower needs are expected to triple in the period 1969-74."

Four of the recommendations relate to reducing sulfur oxide emissions. Although "at least 25 processes are under development in this country for removing sulfur oxides from stack gases . . . proven technology that will solve the sulfur oxides abatement problem is not available today." First priority, however, in the "air"

section of the *Supplement,* relates to the monitoring of global pollutants (for which, see Dr. George Robinson's article, pp. 18-27). Second priority is given to a recommendation that was not in the original book: "An intensive study should be made of the air pollution in a single city in all of its ramifications . . ." In support of this suggestion, the Society notes that "one serious obstacle to logical planning of environmental management of the air resource is the fact that the complete pollution envelope of a single city has never been explored in adequate detail." Such a study is now planned for St. Louis, Mo., as a joint project of a number of organizations, but "there is no indication to date that the necessary funds will be made available."

In the "water" section, the first priority relates to the growing public use of water supplies containing treated waste-waters from upstream. Waste-water treatment is imperfect, and probably some harmful substances in treated water are still not even detected. So what is needed is "research on removal or destruction of low concentrations of harmful substances and organisms that now pass through the waste treatment process unchanged or whose fate in the process is unknown." Such work belongs with the Bureau of Water Hygiene, and needs $2 million a year as against the $160,000 of fiscal 1970.

Solid wastes, unlike air and water pollution, tend to be a local problem, the Society notes. "A large part of that problem is simply the difficulty of inducing the responsible parties to pay for what needs to be done. The technology is available to upgrade sharply the handling and disposal of municipal refuse. . ."

The fourth and last section of the *Supplement* relates to pesticides. The most important immediate action, the Society considers, is "to teach all users the optimum methods of pest control." Among the needs for new research, top priority goes to the "interaction between environmental pesticide contaminants and biological systems," in order to confirm or refute those current allegations of ecological damage which "are based on circumstantial evidence only."

Minicomputers . . .

What is it that measures less than two feet in any direction and will be worth $1 billion a year (or more) by 1975?

The answer is a minicomputer, and that billion dollars is made up of a million of them at $1,000 each.

That was the picture presented, on the basis of reputable current forecasts, by John J. Morris, President of Custom Computer Systems Inc., when he addressed a seminar on electronic data processing organized by the M.I.T. Alumni Center of New York in January. Custom Computer Systems is not itself in the business of making minicomputers; it is one of those companies that will figure out an arrangement of the available hardware to do a particular job. The minicomputer's usefulness derives from the fact that it is cheap enough ($10,000, falling rapidly) to be arguably worth buying merely to do one repetitive clerical or factory task—even if it is sitting idle much of the time (whereas computing time on a conventional machine is too expensive to waste). Mr. Morris stressed that this is a basic advantage of a minicomputer: there is no need to worry about maximizing its effective use.

In one way, he said, the minicomputer brings back the old days of computing: the programmer has the machine to himself, "right there," and he can physically tinker with it if need be (Mr. Morris remembered an occasion when a circuit fault had been detected, located, and repaired on the spot in an hour and a half).
The main limitation of this "different kind of world" is that the circuitry—limited as it is in amount and variety—lacks the special-purpose logical and arithmetic functions that enable conventional modern computers to do complicated things very quickly. The minicomputer is pedestrian in its methods. In many accounting and production-control applications this does not matter. If it does, one can tinker with the thing, adding on special circuits.

Until now, the tendency in designing a computer system, where a large number of separate tasks must be done, has been to install a single large processor (costing perhaps hundreds of thousands of dollars) connected to the various workpoints octopus-fashion. Mr. Morris noted that a number of organizations, where the promise of this approach has not been fulfilled, are turning to the use of separate minicomputers for each task.

. . . and Other Small Things

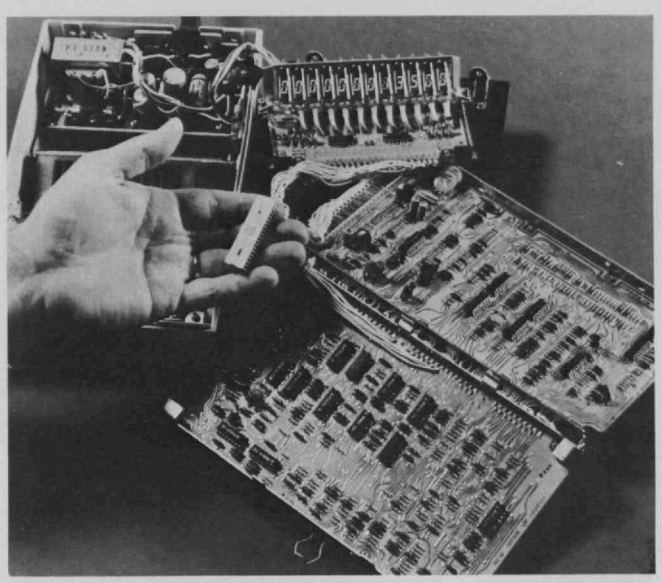
The current state of the art of miniaturization is illustrated by the photograph, in which a calculator of fairly recent design forms the backdrop for a single large-scale-integrated circuit. The single-chip circuit is equivalent to both panels of the earlier calculator, which is an N.C.M. (Nippon Calculating Machine Co.) "Busicom Junior," itself consisting largely of integrated circuits.

The single-chip calculator is the result of a cooperative project by N.C.M. and Mostek, a Texas affiliate of the Sprague Electric Co. The project was begun, by two N.C.M. engineers and a Mostek "logistician," in June 1970, and the first units were delivered to N.C.M. at the end of the year. At the time of writing, an output of 5,000 per month was planned.

Mostek's marketing vice-president, Berry Cash, expresses confidence that "even more complex logic and therefore more complex machines will result from our continuing relationship with N.C.M."

But you don't have to be a logistician to like large-scale integration, it would appear. Robert A. Hirschfeld, president of Lithic Systems, Inc., Cupertino, Calif.,

The two circuit panels in the background comprise the logic (mostly integrated circuits) of a "Busicom Junior" calculator. The single chip in the foreground carries the same logic; it results from a U.S.-Japanese collaboration that began less than a year ago.



observes that while the integrated-circuit industry in general has been preoccupied with computers, chances have been missed in the communications market. "We plan," he says, "to introduce monolithic integrated circuits which we hope will cause the revolution in the field of communications which was seen over the last five years in the minicomputer and calculator business."

Lithic Systems is therefore developing monolithic circuits which will "perform entire subsystem functions in two-way radios, navigation, guidance, remote control and data-transmission equipment," starting with a range of these "monolithic subsystems" designed for walkie-talkie sets and the like.

The minicomputer is sometimes said to relate to its predecessors as the model-A Ford related to the hand-built automobile: cheap enough to be worth buying and simple enough to play with. Asked whether there was any analogy, in his "monolithic subsystems" approach to communications, with this model-A quality of the minicomputer, Mr. Hirschfeld thought that there was.

Mr. Hirschfeld sees the integrated-circuit walkie-talkie as being mass-marketed, "eventually as a consumer item." Such widespread use raises problems of competition for bandwidth, hence a need for systems of modulation and signal coding such as are at present practicable only in military equipment. The volume production of cheap, complex integrated circuits could perhaps remove the cost limitation and give every man his slot in the spectrum.

A Sleeping Quasar In Every Galaxy?

A couple of years ago, M.I.T.'s Professor Philip Morrison proposed a new class of astronomical object—the spinar. He now suggests that there may be an undetectable spinar at the hub of every galaxy.

Observationally, the spinar can exist in two forms, on very different scales of size, the pulsar and the quasar. The former is a tiny star that gives off flashes of light every second or so (give or take an order of magnitude). The latter is a contracted kind of galaxy; it is observed as a very compact but strong source of light and radio energy. The observational connection is that one of the 200 known quasars pulses, although very slowly (about once a year). Both pulsars and quasars, according to Professor Morrison, can be viewed as spinning beam-generators, like celestial lighthouses (*see* Technology Review *for January 1970, pp. 63-64*).

Speaking at an M.I.T. Alumni Regional Conference held in Washington this spring, he told of a new difference —in his view—between pulsars and quasars. Observably, pulsars are slowing down. It is as if the energy that they emit is ultimately derived from a loss of angular speed, like a running-down dynamo. But, says Professor Morrison, whereas a pulsar is a condensed mass of atomic nuclei, a quasar is composed of rather rare gas. As the quasar loses energy this gas contracts, while its angular momentum drops. Although it will take years to prove it by observation, the rate of rotation of a quasar should steadily increase. It emits strongly because it converts its gravitational energy into spin energy.

As the quasar spins faster and faster, the motion of its outer parts will eventually come close to the speed of light. But before that, by one effect or another it "sedately stops giving light but goes on spinning like a sleeping top. It simply has no more electrical interaction with the outside world."

The quasars that have been observed all seem—according to one interpretation of their properties—to be extremely distant. We are therefore seeing them as they were thousands of millions of years ago. So what has happened to the nearer quasars, which we should be seeing at a later stage of their development? Professor Morrison's suggestion is that they are hidden at the centers of many galaxies, including our own.

"Possibly our galaxy has a sleeping spinar at the center of it. We know our galactic center does things that are rather odd." According to the late Mr. Eliot, "at the still point of the turning world" there is "neither arrest nor movement. And do not call it fixity, where past and future are gathered . . ."

A Road Improvement That Seems to Work

Drivers entering Route 38, southbound, from Woburn (one of the northern suburbs of Boston) in recent months found themselves being cared for in a most unaccustomed fashion. Their access ramp was fitted out, experimentally, so that the driver had only to follow a moving light signal and he would enter the freeway precisely where there was a gap in the traffic. Many were astonished that the thing really did the trick. More than 60 per cent approved of it. There were two versions, both the work of Raytheon's Traffic Control and Surveillance Systems team, the manager of which, Mr. David Bushnell, recently gave a seminar at M.I.T.'s Urban Systems Laboratory.

The underlying problem is familiar to every driver. The flow of traffic on a crowded freeway can be very sensitive to the arrival of additional vehicles: too many, and the flow abruptly slows down. A more subtle interference with the flow is the maneuvering that goes on. At present there are two solutions. The first is very unpopular with the motorist—seal off the ramp completely when the freeway is judged to be full enough. The second is using signals to limit the frequency at which vehicles enter the freeway, according to some estimate of the road's spare capacity. This method is widely used, and in fact works.

But there is still the possibility of working much closer to the real capacity of the freeway at all times, by sensing and controlling individual vehicles. By matching gaps in freeway traffic to specific vehicles moving in on the ramp, it should be possible to achieve a highly efficient use of the road.

This is what Raytheon has been doing on Route 38. The test runs are now concluded. Whether or not the benefit proves to justify the cost, most drivers seem to have approved of the system.

It consisted essentially of three parts—sensors, computer, and signal lights. The sensors were the conventional inductive loops—conductors carrying alternating current, whereby passing vehicles can be detected as variations in impedance. The computer, a Raytheon machine, had the pattern-recognition task of finding gaps of adequate length between vehicles on the freeway and predicting when each gap would reach the merging point; at the same time, the computer instructed drivers on the ramp as to how they should proceed in order to be there at the right moment. This was done with two kinds of signal, both using the same equipment—lamps ranged along the ramp at 8-foot intervals. Either one lamp was switched on at a time, to create the effect of a moving spot which the drivers followed, or a group of adjacent lamps were switched on, making a "green band" which mimicked the gap that the driver would enter if he stayed with it.

By means of inductive loops on the ramp, the computer was able to track the driver's progress, so that if

To guide each incoming car to a gap in the freeway traffic, a band of green lights moves up the access ramp under the control of a computer, which obtains its data from rectangular induction-loops sunk into the road. This is one version of a traffic improvement system recently tested by Raytheon.

he fell irretrievably behind he could be told that he was on his own again.

It may well be that the next step is overall adaptive control of freeway traffic, using this type of ramp system only as and when required. The demonstration that an electronic system can make correct observations of, and decisions about, individual moving vehicles, at least indicates clearly that motor traffic need not be completely mindless.

It is now about five years since the Federal Highway Administration began trying to encourage the application of aerospace-grown methods to earthbound tasks. It would appear that the new technology and "systems thinking" (there is really no way of being sure how

people are thinking, though) do indeed have their uses. Incidentally, those who regard the military-industrial world as lacking in moral tone may be surprised to hear of one of the obstacles facing the defense contractor who tries his hand in the road business. The contracting of highway work is assumed to be primarily a matter of influence. It is only with difficulty that the newcomer can persuade potential clients that he is making a genuine attempt to satisfy a need.

Taking the Worry Out of Being Close

Comprehensive and worthy studies have been done on urban rapid transit, and what to do to coax people out of their cars and into a train (assuming that there is one). A study by Robert Lepper, of Carnegie-Mellon University, and Robert K. Moorhead, of the Rensselaer Research Corporation, makes bold to suggest that the reason that cars continue to jam the Golden Gate and George Washington Bridges is because a lot of people don't like being near a lot of other people.

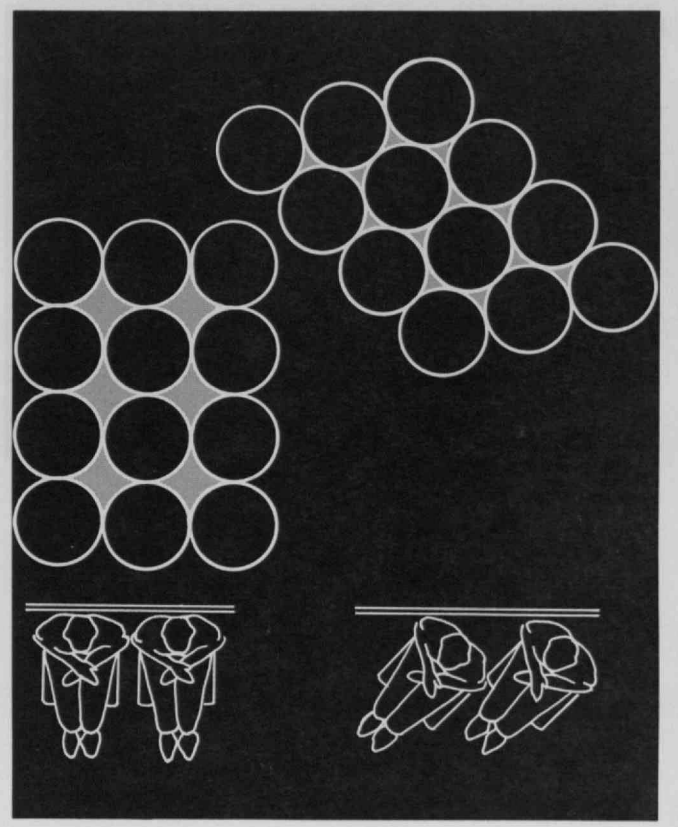
"The real rider may be utterly miserable on his first (or hundredth) trip in a superbly air-conditioned and vibration-free vehicle of a splendidly planned new system which operates on an ideal schedule at half the fare of the old system," they say. "The real rider will be miserable in this abstract and quantitative paradise" if he is exposed to invasion of his person or the loss of his dignity.

They identify causes of distress: elbows, shopping bags and brief cases, allergies, newspapers, wet clothing, soiled clothing, and body odor ("any seasoned rider can expand the list"); they identify also certain persons: sprawlers, sleepers, drunkards, oglers, and babies. Various "irrational prejudices" make life even harder. The rider must maintain his composure under these insults—he cannot lose face even though those around him do not abide by the rules of manner and control he believes in. Since there are different codes for different classes, the authors posit, "it is predictable that potential indignity to person and homogeneity of patronage are in inverse ratio." They add: "One finds a very pervasive difference between middle and lower class males in American society. Those who work without a tie . . . and persons who can afford to touch and be touched . . . need not maintain a tight orientation in public social situations."

That urban transit is often seen "as minimal accommodation for those who have no modal choice," according to Lepper and Moorhead, also "invites the rejection by one social class of the behavior of another: Why ride public transit if one can afford private conveyance?"

A transit car offering easier movement and more privacy ought to reduce the psychological stress. Present longitudinal or crosswise seats almost force contact with seatmates. The crosswise ones, particularly, parcel

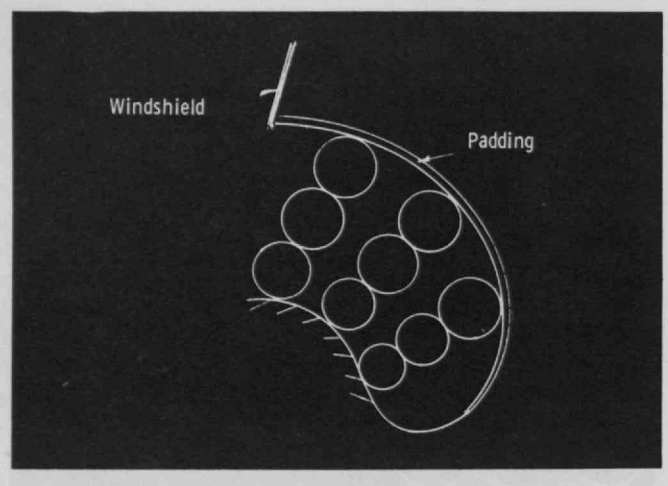
If people were beer cans—which researchers make haste to admit they're not—more of them could be fitted into less space using the transverse arrangement to the right rather than the usual one to the left. One wastes 21 per cent of the space; the other wastes only 9. Applying this configuration to subway seating yields the transverse alignment shown below—one that gives more room and less aggravation to each rider. (Chart: Lepper and Moorhead.)



out precisely 20 inches per rider, all very well for two 18-inch sets of buttocks, but not for two 22-inch sets of shoulders (wider than average, but not uncommon). With this design, the aisle passenger is almost sure to be buffeted by standers or riders moving up the aisle. Sitting on a longitudinal seat means accommodating two seat-mates and almost certain eye contact with those opposite. Those riders not possessed of a seat, although less secure, at least have the advantage of being able to move without relinquishing a piece of property—the seat—and losing face.

Mr. Lepper and Mr. Moorhead propose switching seats to the one position not yet considered—an angle facing into the aisle. Seats would be single, so the extension into the aisle (with occupant, 31½ inches) would be slightly less than that of a transverse seat (34 inches) or double seat (40 inches). They suggest that this design would accommodate as many riders sitting and standing combined, as either of the others, and reduce confrontations to only those between one sitter and one stander.

Padded dashboards provide uncertain and generally inadequate protection for automobile passengers in crashes. Instead of relying on padding, suggests Nicholas Perrone of the Department of Civil and Mechanical Engineering at the Catholic University of America, use a bundle of tubes for shock protection. Impact strength properties of an automobile bumper could be improved with similar construction; indeed, said Professor Perrone at the annual meeting of the American Society of Mechanical Engineers this winter, "designers should be limited only by their own ingenuity in considering many possible combinations of tube elements for application to the various critical parts of an automobile."



Tubes and Air Bags

Now that most automobiles are equipped with collapsible steering columns and nearly all with lap belts, the instrument panel and windshield (instead of the steering column) have become the principal sources of injury to passengers during crashes. Indeed, both flexible steering columns and lap belts serve to increase the passengers' exposure to windshield and dashboard.

Hence the need for a new generation of crashworthiness improvements, Nicholas Perrone of the Catholic University of America and Office of Naval Research told the American Society of Mechanical Engineers this winter.

For example, said Professor Perrone, the padding as now required on instrument panels and windshield supports is obviously insufficient protection. In its place, he said, consider the tube—an economical structural element whose stress response is fully predictable. A tube under impact collapses as if hinged at four points (to become a sort of flattened figure-8); all its deformation is confined to the four hinge areas.

If your head strikes an unpadded windshield header at 30 ft./sec., the deceleration may be as high as 500 g—almost surely a fatal blow, said Professor Perrone. But if the header is fronted by a one-inch (radius) steel tube, the deceleration will be about 80 g—a painful but not lethal encounter; "a high probability of survival would result," he told the A.S.M.E. "The tube offers an attenuation mechanism which merits serious consideration."

What of the controversial "air bag"—a low-pressure balloon arranged to inflate under rapid deceleration to fill the passenger compartment and provide a cushion between the front seat occupants and the car body? Though he admits that "there is little doubt that air bag systems will some day be operational on all automobiles," Dr. Perrone joins the ranks of the cautious. The National Highway Safety Bureau proposes that air bags might save 1,200 lives during their first year of full deployment; this implies installing air bags on all new cars (some 9 million) in some future year. But, says Professor Perrone, if you assume a failure rate of only 0.1 per cent, you anticipate 9,000 misfires in 9 million installations, from which "it is likely that a greater number than 1,200 fatalities would evolve."

Dr. Perrone's suggestion is a phased testing program: install air bags on perhaps 30,000 cars in the first year, and more—if the reliability is in fact sufficient—in a second year, gradually working up to full deployment. Two other reservations about the air bag: even if it can be manufactured to high standards of reliability, what about maintaining that reliability through a car's lifetime? And what about the noise of the "detonation," which will apparently be "near the threshold of pain and permanent ear damage"?

Hillside Highrises

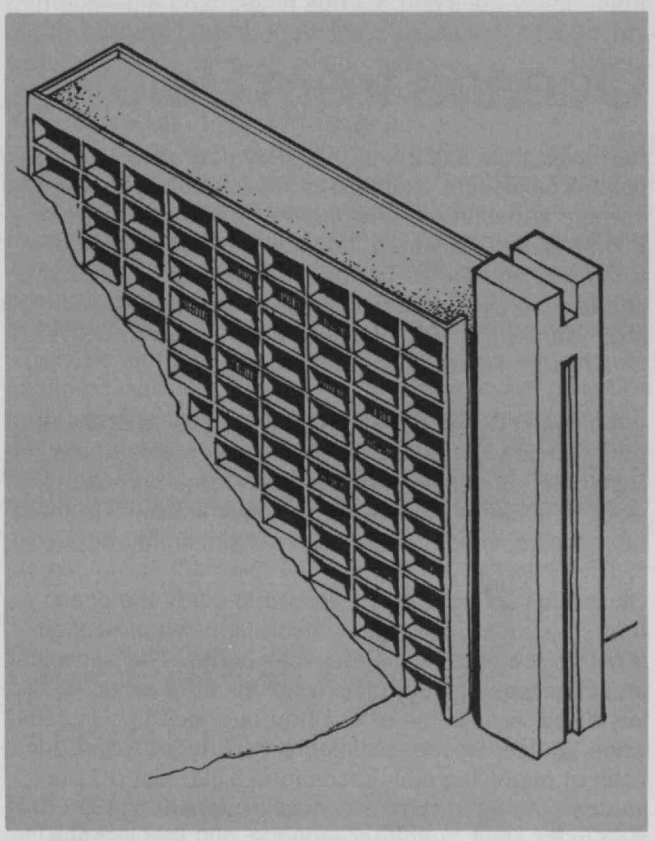
A computer-based analysis of foundation requirements leads Waclaw P. Zalewski, Professor of Structures in the M.I.T. Department of Architecture, to a new system for erecting high-rise buildings on steep hillsides: set the length of the building perpendicular to—instead of parallel with—the hillside, and let the structure lean gently against the slope from a fulcrum at the base of the hill.

Professor Zalewski and his research assistants—M. Robert Kirby and Reinhard K. Goethert—envision a multistory building, the front of which is a tower-like structure rising straight up from level ground at the base of the slope. Extending to the rear from the tower until encountering and resting against the natural slope

of the hill, the floors of the building would then be progressively longer from bottom to top. The structure is supported by the interaction between vertical and slanted piles under the tower portion of the building and a shallow strip foundation which acts as a weight distributor pressing against the full length of the slope.

Thus the weight of the structure is shared between the strip foundation and the piles beneath the tower section in what Professor Zalewski calls a "twofold response" system which works against the tendency of the building to slide downhill—and, indeed, of the hill itself to slide. He thinks it will cost no more than a conventional foundation—and thus open up to building land which has heretofore been considered useless for the purpose. Builders in Pittsburgh and in Venezuela are already studying the system.

Pilings under the front tower and a shallow foundation under the rest of the building would carry this structure, making it unnecessary for the builder to excavate its hillside site. A new foundation system developed by an M.I.T. architectural research team makes possible use of hilly terrain for high-rise construction without serious cost penalties, according to Waclaw P. Zalewski, Professor of Structures in the Department of Architecture.



Requiem for An Ivory Tower

Education in engineering and the sciences, one of the last areas of education to come down from the proverbial ivory tower, is responding to the "join the real world" spirit of the times—but not without growing pains.

Walter A. Rosenblith, Associate Provost at M.I.T., at a recent gathering at the National Bureau of Standards spoke of interdisciplinary, problem-oriented learning; concern for ultimate results; and an emphasis upon filling the needs of the nation. These, he said, will be the goals of technical education in the coming decades.

Under persistent pressure from determined students who wish to acquire a set of skills that zig-zag across traditional departmental divisions, institutions like the Massachusetts Institute of Technology are groping toward educational policies and structural mechanisms that will make this style of education available. "The complexity of real life is such that no single structure, no single way of cutting up the educational pie is going to be able to do this. But the fact is that today students can change curricula very much differently than can faculties," said Dr. Rosenblith, noting that to change curricula is about as easy as to move a cemetery.

In connection with the increasing interaction between campuses and the outside world, Dr. Rosenblith noted that we have transformed our environment from a mainly natural one based on an agricultural society to a mainly man-made one. The engineer is no longer engaged simply in a struggle with nature, as he once was. He faces situations that were formed by previous human choices of all kinds, and his work will tend to constrain other choices, now and in the future. This is why his problems require new interdisciplinary approaches, even though the solutions are still technological. Though still in its infancy, increased funding for university research grants in the biomedical sciences and technology, urban affairs, and environmental problems suggests that the new frontier of basic research on the campus will be in these fields—the study not simply of nature, but of today's mixed, human/natural world.

Dr. Rosenblith noted that in this matter there is a resonance between trends on the campus and what happens in Washington. In support of this he cites this year's N.S.F. budget for "research applied to national need"—to the tune of 15 or 20 per cent of its total research support. This new wrinkle in N.S.F. funding is neither fluke nor fad, he asserts, but the wave of the future.

Thinking about science and the consequences of science will be "one of the major activities that will distinguish the next period of science from its predecessor," said Dr. Rosenblith. He believes that concern for the ultimate application of new knowledge must become an integral part of a technical education because this is "a task we cannot leave to philosophers and specialists."

Deep Submergence Research Vehicle Alvin, *which sank in October, 1968, and was retrieved the following year, has been in the hands of Woods Hole Oceanographic Institution's engineers and should be ready for test dives in May. A heavy schedule awaits Woods Hole's only submersible.*

Oceans from Below

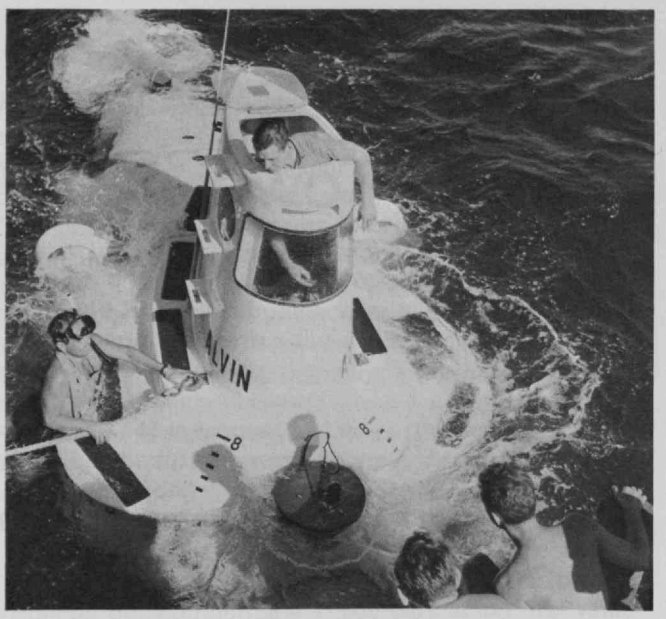
Retrieved from 5,052 feet in a 1969 operation that was itself an excellent example of submersibles' search and salvage capabilities (*Aluminaut's,* in this case), Deep Submergence Research Vehicle *Alvin* is being rebuilt with new instruments to replace those that were damaged by her ten months in Hydrographers' Canyon. This May she begins test dives with the catamaran DSRVT-1 *Lulu* (DSRV Tender-1) supporting her.

In June she will begin a six-month schedule of dives now planned to range from the Gulf of Maine to the Bahamas. Chief scientists on these dives propose to work in fields as diverse as soil mechanics, instrument emplacement and retrieval, and current monitoring.

Once such scientists were forced to study the ocean from its surface, lowering sensors and sample-collectors into the vast invisible spaces below. Their physical presence was limited, for physiological reasons, to shallow dives. A new line of attack was opened up in 1934, when William Beebe, a biologist frustrated by the limitations of his diving suit, descended 3,028 feet off Bermuda in the bathysphere he had designed. In 1960 two men in a bathyscaph descended 35,800 feet into the Mariana Trench, the earth's deepest known submarine canyon. As they touched the abyssal bottom, they saw a fish—and answered a long-standing question: Does life exist in the abyss?

Since she arrived at Woods Hole Oceanographic Institution in 1964, the 23-foot D.S.R.V. *Alvin* has been helping scientists answer other long-standing questions. Before she sank in October, 1968 (with no lives lost), *Alvin* had dived 307 times with ocean researchers in many disciplines aboard her. They had observed directly, and monitored selectively, ocean phenomena which until the advent of submersibles they had been able to study only secondhand.

In a submersible, for example, a physical oceanographer can measure directly and continuously a particular current-shear microstructure. Or a geologist can assess, with greater accuracy than he can from surface-vessel sampling, the locations and extents of gravel and sand deposits (which are of increasing commercial interest). A biologist can study groundfish spawning areas



or watch a deep sea beast feeding, to see for the first time what might be the purpose of a heretofore puzzling anatomical configuration. An ocean engineer can receive direct feedback in instrument tests that will help him improve equipment designs.

Woods Hole scientists' requests for diving time are many, urgent, and specific—especially because they have been without a submersible for two years. Even with a six-month tentative diving schedule, *Alvin* will not be able to fulfill all these requests, and the number of dives planned could be reduced by as much as 50 per cent by weather, mechanical difficulties, and time in transit (*Lulu,* the vehicle's tender, has a sustained speed of 6 knots for 1,200 miles).

Alvin's basic instruments for scientific observations originally included: a remotely controlled mechanical arm (which she once accidently detached and subsequently retrieved) with sample trays and jars; underwater cameras with the necessary strobes and incandescent lights; a tape recorder; a water temperature monitor; a current speed meter; and a precision depth indicator.

William O. Rainnie, W.H.O.I. oceanographic engineer in the Deep Submergence Engineering and Operations Section, has said that future plans for the submersible

include a titanium pressure-hull sometime in 1972, with a projected depth capability of 12,000 feet, to replace the existing steel hull, tested to 6,000 feet. The Section's engineers are also working on the electrical design and stress analysis of new bottom-penetrations to go with the titanium hull.

The group is also planning procedures whereby W.H.O.I.'s newest research vessel, the *Knorr,* could support submersible operations. This proposal could increase the number of dives *Alvin* could make by greatly decreasing the submersible's travelling time. Mr. Rainnie has pointed out, however, that until the government's view of the priority of accomplishing useful work in the ocean is reassessed and raised to the appropriate level, submersibles will not be used to their full capabilities as research tools.—*Lucy Sloan*

Oceans from Above

Oceanographers' observations of their subject are perhaps the most limited of any science: ships, buoys, and dredges are specks in a perpetually heaving, opaque, unfriendly universe of 330 million cubic miles. Hence the oceanographers' interest in satellites: "To those who have worked from ships, aircraft, and submarines covering small patches of ocean each day, the prospect of quantitative semidiurnal observation of the whole world ocean is a bright one indeed," wrote Smithsonian Astrophysical Observatory reporters in 1969, after a two-week N.A.S.A.-sponsored inventory of satellite applications led by William S. Von Arx, Professor of Oceanography at M.I.T.

An orbiting sensor would give oceanographers at least four kinds of data to which they now have little or only inadequate access: the patterns and volumes of primary ocean currents, tides, waves, and possibly tsunamis; the shape and strength of the earth's gravity field as recorded by the height of the ocean; the intereffects of ocean, atmospheric pressure, and wind; and the volumes and motions of sea ice.

Some of the satellite's advantages are obvious. It could solve the oceanographer's perennial problem of knowing his precise position on the surface of the sea, and it could similarly help him locate an exact spot on the sea floor. (Radio navigation now gives locations accurate only to ±100 m., and velocity measurements only to ±5 cm./sec., within 100 miles of land—although much better can be done very near the coasts—and navigation is only one-tenth as accurate farther offshore.)

Satellites will help solve the problem of charting currents, too. Floating, transponding buoys could be located by a satellite every time it passed overhead, even hundreds of miles at sea. A transponding deep float, which may have drifted, submerged, as little as 0.6 to 6 km. in a full week, must be located almost at once upon surfacing if currents and winds are not to erase its deep-water history; a satellite would assure oceanographers that their receivers were in the right place at the right time.

Such improvements in locating and tracking abilities would alone produce "a quantum jump in open ocean research and survey opportunities," says the report (*The Terrestrial Environment: Solid Earth and Ocean Physics,* N.A.S.A. CR 15-1579).

More exotic applications of satellites have to do with measuring minute, dynamic variations in the height of sea level. The crucial issue here—still unresolved—is how accurately a satellite can be made to measure its height over water. A resolution of ±5 meters would yield useful information about the shape of the earth but very little real oceanographic data. A resolution of ±1 m. would permit detection of tides, storm surges, and—perhaps—the changes in surface elevation which mark major currents. But the ideal is a resolution of ±0.1 m., which would give the detailed observations required to fulfill oceanographers' dreams of mapping the general circulation of the world ocean.

For the latter, there must be very precise observations—±½° in phase and ±2 cm. in amplitude—of the tide; from these could be calculated tidal energy dissipation. And sea surface slopes must be measured to similar accuracy to locate and map currents. There would be one immediately useful product: such accuracy would surely be sufficient for detecting tsunamis—earthquake-caused tidal waves—in the open ocean, long before they are pushed to dangerous heights on the continental shelves. In the longer range, there could for the first time be real answers to questions about the distribution and transport of substances in the oceans—questions "which must be answered if disasters are to be avoided in their exploitation," says the report.

Decentralizing Research

The large, centralized industrial research and development laboratory may soon be a thing of the past, because success in technology now may depend more on people than on technology itself, says Richard S. Morse, Senior Lecturer in the M.I.T. Sloan School of Management.

Speaking to a seminar of Institute alumni early this spring, Professor Morse suggested that the technological basis for U.S. industrial growth may be changing. We're discovering that "you don't necessarily build new products from technology," he said; "you build them from people who can market what they make." The need today is for closer coupling between research and the marketplace, Dr. Morse told the M.I.T. graduates, and doing research in an ivory tower doesn't provide it.

Instead, Dr. Morse suggested, future successful research and development efforts will be done in many companies by small, market-oriented groups of research and sales engineers working together. They will be far more responsible—and responsive—to the customer's needs.

The Productivity Crisis

Inflation is what happens when wages go up (13 per cent was the average rise in major collective-bargaining settlements in the U.S. in the first three-quarters of 1970) faster than the rate of productivity increase (3.1 per cent from 1970 to 1975, according to estimates of the Council of Economic Advisers). The difference has to go into prices, and it is now producing for the U.S. what Gordon F. Bloom, Senior Lecturer in the M.I.T. Sloan School of Management, calls the "productivity crisis."

Continuing inflation will be accompanied by ever more critical problems—increasing demands from the poor, accentuated resentments by the middle class, and greatly magnified costs of attacking "all the problems which need to be solved to improve the quality of life in this nation." Even "environmentalism" is inflationary, increasing the cost of doing business and thus pouring purchasing power into the income stream while perhaps even retarding productivity.

Mr. Bloom dismisses wage and price controls. Writing in the winter issue of the *Harvard Business Review,* he says simply, "In a free economy in peacetime, we cannot effectively control prices, and *a fortiori* we cannot effectively control wages."

Instead, Mr. Bloom proposes to cultivate U.S. productivity; he is convinced that the potential for its increase in the U.S. still is "enormous." No other country has our wealth of technical knowledge; waste and inefficiency—our room for improvement—are vast. But competitive industries cannot by themselves do the job; we need new industry-wide coordination (perhaps by the new National Commission on Productivity?) "to help industry take the long view of the complex operational and distribution problems that now extend beyond the perimeters of individual companies."

Here are a few examples of what Mr. Bloom thinks could be done:

1. Adopt a modular packaging system. Chain food warehouses (Mr. Bloom was in the chainstore food business before he turned to teaching at M.I.T.) now have to contend with over 1,500 different sizes and shapes of cartons. Their number makes handling difficult, makes automation futile, and increases damage.

2. Stop the trend toward greater proliferation of products. The airlines are beginning to do it by reducing schedules; toothpaste makers are now providing five (instead of 57) different sizes of packages; detergents come in only 8 (instead of 24) different size containers. But consumers remain "angered and confused by the variety of sizes, models, grades, and types of products in the marketplace," and production and inventory costs are increased.

3. Consolidate production facilities to fully capitalize on the advantages of technology and mass production. (Antitrust laws as presently interpreted work against such economies, Mr. Bloom notes.)

4. Eliminate make-work practices, most of which are enforced by organized labor. It can be done, says Mr. Bloom, with "buy-out agreements that offer workers . . . compensation in return for modernizations that will improve productivity per man-hour." (An example is the 1960 agreement between the Pacific Maritime Association and the I.L.W.U. dockworkers' union.)

Natural Voltages, High and Low

We live not only in a weak magnetic field, but also in a vertical electric field with a surprisingly high voltage gradient, of the order of 100 V. per meter. The magnetic field found just one application, centuries ago, in the mariner's compass. The electric field has not yet been harnessed to any practical purpose, although Benjamin Franklin made it ring an electric bell in 1752. The past few months have brought news of fresh advances on both fronts.

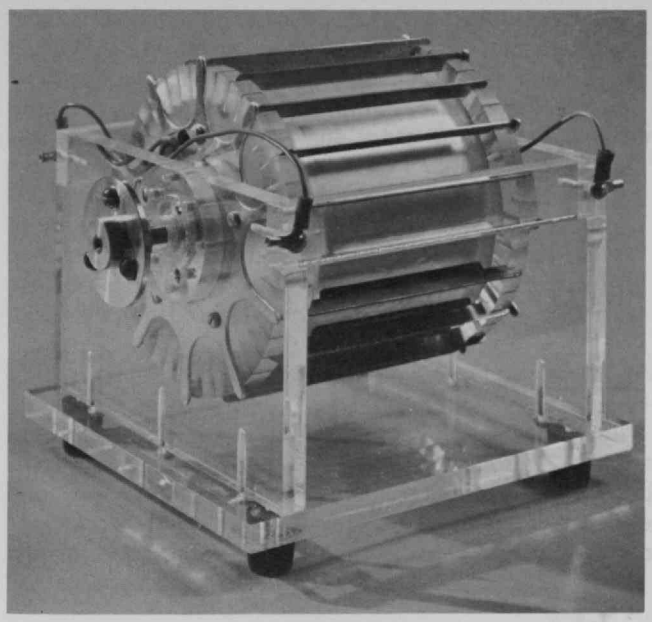
The shortcoming of atmospheric electricity is that the currents available are very small. Nevertheless, Oleg Jefimenko of West Virginia University has managed to run specially designed electric motors from this natural power source. In his first such success, he used a 24-ft. antenna to supply several hundred volts to an "electret" motor, which turned over at 60 rev./min. and generated, he estimates, a millionth of a horsepower. (An electret is—by analogy with a permanent magnet—a body which retains an electrostatic polarity indefinitely.) With another kind of motor, powered from a balloon-borne antenna, one ten-thousandth of a horsepower was developed.

Dr. Jefimenko hopes that applications for this kind of power source will emerge. (He points out that as late as 1890 a textbook published in New York stated that there could never be any practical use for any kind of electric motor, because electricity cost far too much to generate as compared with steam.)

But the above-mentioned advance in the use of the earth's magnetic field started out with a ready-made application—the measurement of deep ocean currents (currents of water, that is, not electricity).

In 1968, Dr. Thomas B. Sanford, an Oberlin and M.I.T. physics graduate at the Woods Hole Oceanographic Institution, applied the theory of magnetohydrodynamics (M.H.D.) to one of the central problems of physical oceanography, current measurement. When an electrically conducting fluid moves through a magnetic field, voltages are induced in it whose magnitude depends upon—among other things—the speed of the fluid. A magnetic field is supplied by the earth. So one could in principle sense ocean currents at any depth by dropping some kind of voltage-sensor.

The ocean's M.H.D. voltages are very small, and the sensor cannot be connected to a ship by wire because the ship's own charge would disturb the electric fields



A "corona motor" which Dr. Oleg Jefimenko of West Virginia has succeeded in powering from the natural steady-state atmospheric electric field. With a balloon-borne antenna as a high-voltage current source, the corona motor generated one ten-thousandth of a horsepower.

to be measured. The instrument now exists: it is free-falling, transmitting its readings acoustically and returning to the surface for reuse after it has touched bottom. The "staggering" technical difficulties of designing it were solved by Robert Dever, of the Institution's Department of Ocean Engineering, and the spinning electromagnetic ocean voltmeter is now a working research tool. But, says *Woods Hole Notes (Vol. 2, No. 6)* "even today, it requires constant nursing between drops."

A Plea for Dispersion

The problem of pollution is not a problem of air. There is plenty of air, and the problem is much less the production of pollutants than their dispersion, Hoyt C. Hottel, Professor of Chemical Engineering, Emeritus, at M.I.T., told the undergraduate newspaper *Ergo* in a special interview this winter.

If you allocate to the U.S. that portion of the earth's atmosphere which is over its territory and an appropriate share of the air over the oceans (on the basis of the U.S.' share of the earth's total land area), less than two feet of U.S. air is consumed in one year by U.S. combustion processes. Professor Hottel calculates that the earth is surrounded by 20,000 feet of atmosphere with the density of air at sea level, and so we use less than 0.0001 of our share a year. And this, he says, makes no allowance for the regeneration of the atmosphere which is constantly underway through meteorological and photochemical processes.

This analysis leads Professor Hottel to several observations:

◇ "One is almost justified," he says, "in saying that East Coast plants should be allowed to burn high-sulfur fuels when the wind is blowing from west to east . . ."
◇ "Legislation about pollutants should take into account investments to produce better dispersion of those pollutants." High stacks, for example, should "receive some credit in the bookkeeping about who makes pollution."
◇ And we should note that processes for partly removing pollutants from stack gas often have the effect of cooling the gas, thus reducing its dispersion by reducing its buoyancy.

Professor Hottel emphasizes that none of his comments is intended to deny the existence of serious air pollution problems associated with combustion.

Clean, Safe Mines

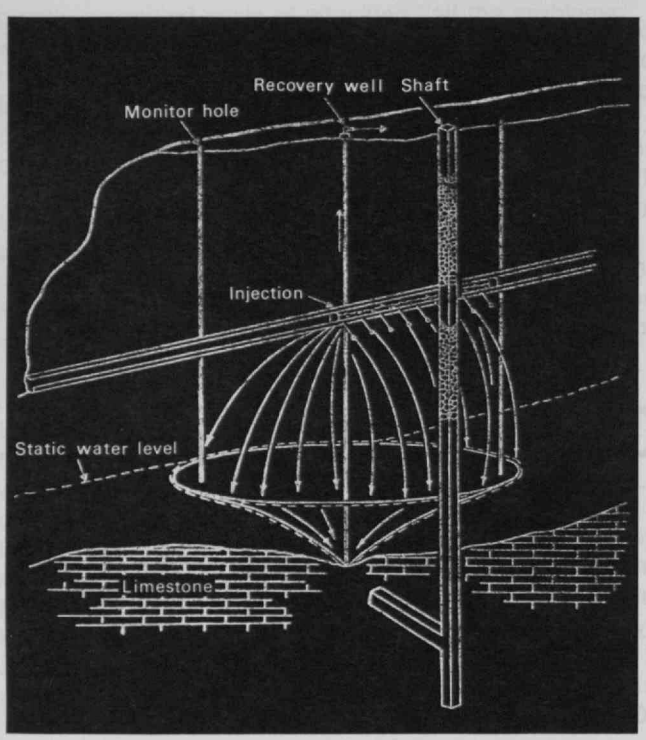
A solution proposed to the problem of acid drainage from coal mines also resolves the problems of fire and explosions and of the occupational disease, black lung. The solution would increase construction costs by 12 per cent and operating costs by 4 per cent, but if the mine produces natural methane the gas could, with this plan, be collected and sold, adding up to 20 per cent to the mine's income.

J. K. Rice of the NUS Corporation told the American Society of Mechanical Engineers last winter that it is technically possible now to build mines with a controlled atmosphere free of oxygen. (His study is funded by the Federal Water Quality Administration.) A demonstration mine is being built in West Virginia for the Island Creek Coal Company, and it seems that no modifications will be needed in mining practice.

The mine tunnels are built around a refuge station, supplied with power and ventilation direct from the outside, within a few minutes walk from any work area. The station will be protected by a gas lock, as will all interfaces between mine and outside atmospheres. The miner himself will wear a completely sealed life-support suit, with temperature and humidity control. A diaphragm over one ear will let him hear sounds directly around him; the other ear piece, an F.M. receiver, together with a voice-activated microphone, will let him communicate with the rest of the mine, via antenna cables as are used in subways.

The equipment should in no way hinder the miner's activities, Mr. Rice said. And he is safe from breathing

A pilot-plant attempt at mining copper by in situ leaching (see text, right). Acidified water flows down through porous ore-bearing rock, and is drawn out by the central 265-ft. well. The vertical and horizontal shafts remain from earlier stages in the experiment, the horizontal one having been adapted for solution-injection. (H. R. Spedden et al., *Kennecott Copper Corporation: paper to A.I.M.E. Centennial Meeting)*



dust and gas. The mining equipment functions just as well in the changed atmosphere; the whole mine is cooled (to a temperature lower than that in the miner's suit) so the heat generated by the mining equipment gives no threat of touching off an explosion, and in the same process dust is filtered out.

If the mine is naturally a gassy one, the methane released from the coal can provide the atmosphere. Pressure would be steadied by added control devices. The pure methane collected could be sold—in some mines perhaps 15 million cu. ft. per day. If the mine does not provide its own gas the atmosphere would be nitrogen or methane or a combination.

Acid drainage from mines severely damages the lakes and streams nearby, acid produced by the oxidation of moist pyrites into iron sulfate and sulfuric acid. An oxygen-free atmosphere should reduce the production of sulfates by 90 per cent.

Mr. Rice emphasizes that all of the equipment needed for oxygen-free operation is available off the shelf. A few modifications—combining the miners' oxygen supply with his cooling unit into a compact size—are needed, but essentially the system is available and economical. And safe.

Nature's Own Mining Technique

Rising demands for copper are forcing mining companies to look again at deposits formerly regarded as too low-grade to be economical. They are also looking again at a technique that has hitherto been used only in a few special situations—in situ leaching.

In situ leaching can be compared to the geological weathering process whereby many ore concentrations were formed in the first place: water filtering down through the rocks, from the oxidizing conditions near the surface to the airless lower levels, tends over long periods to concentrate different minerals at different levels, a natural process known as secondary enrichment. At the Centennial Meeting of the American Institute of Mining, Metallurgical and Petroleum Engineers (A.I.M.E.) H. Rush Spedden, E. E. Malout and J. Davis pointed out that, in essence, the mining technique of in situ leaching differs from the natural downward migration of minerals only in that, in the mining technique, the solution is designed to alter the reaction conditions, and the products are extracted from the rock before they can reprecipitate.

The diagram relates to a pilot-plant test in eastern Nevada by the Kennecott Copper Corporation, Salt Lake City, of whose Western Mining Division Mr. Spedden is Research Director. The test is being carried out in a porphyry copper deposit, close to a former open-pit mine which had been abandoned as no longer economic. Acidified fresh water is injected via a horizontal shaft that was used for exploration earlier in the experiment, and a 265-ft. well-boring extracts whatever permeates down through the copper-enriched rock.

There is interest in the application of this technique for other minerals, including borax, mercury, molybdenite and, most notably, uranium. G. G. Hunkin, of the Anaconda Company (which is experimenting with the in situ leaching of uranium) listed the possible advan-

tages: low initial investment; the speed with which the technique can be brought into action; minimal undesirable waste products and disposal costs; small labor requirements; safety; and usefulness in otherwise inaccessible deposits. "While there are possibilities for chemical and thermal pollution of underground waters," Mr. Hunkin admitted, "the system under development by Anaconda is designed to be pollution-free. . . . The demands for environmental maintenance alone may provide incentives for the accelerating development of this mining method."

The practicability of in situ leaching depends very much on the permeability of the rock through which the leaching water must flow. (The first phase of the Kennecott experiment was devoted to just this question.) There are a number of methods of opening up a body of rock. The leaching process itself may help, in that volume changes accompany the chemical ones. Failing that, the favored means is hydrostatic pressure.

Nuclear detonations may or may not be of value: there are different views on this point. In one of the special Centennial sessions, J. B. Mudd of Charter Consolidated, Ltd., London, reviewing future mining technology, thought that the opening up of rock masses for leaching was "the most probable application of the underground nuclear blast," and that "such methods may well be proved feasible by the end of the decade." But according to Mr. Spedden and his colleagues, "on closer examination this approach appears to generate more problems than it solves." Processing radioactive solutions raises one set of problems; and while a nuclear device certainly fractures the rock, it also closes previous fractures. There is in fact a considerable amount of science involved in improving the permeability of rock to leaching solutions.

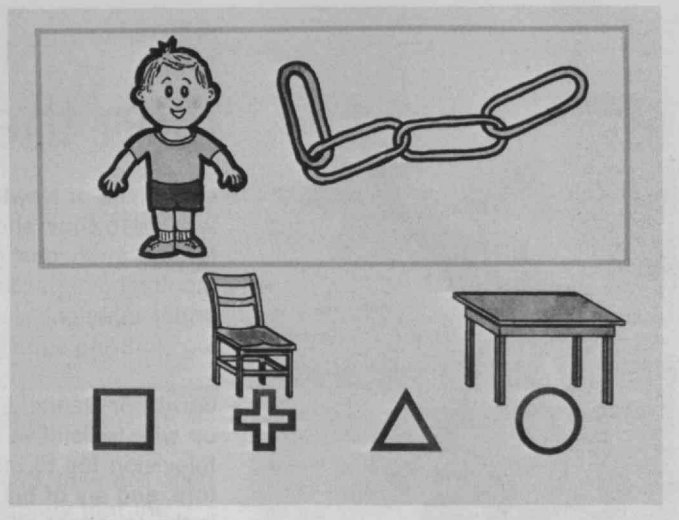
Reading Technology

While billion-dollar A.B.M.'s and S.S.T.'s grab the headlines, a relatively inexpensive audio-visual machine ($350 to $450) developed by Peter Goldmark is teaching "reading readiness" and elementary reading to preschool children in Washington, D.C.

A product of CBS Laboratories, which Dr. Goldmark serves as President and Director of Research, the compact AVS 10 provides individual viewing/listening instruction through program cartridges which play for up to 15 minutes. A recorded narration is synchronized to graphic frames projected on a 5″ x 7″ screen; the learner can advance the program only by pressing the correct one of four response keys.

A typical frame might present the word *tan* along with a graphic display of the color tan. The narration would pronounce the word—at first slowly by discrete sounds, then quickly as it is said in speech. Finally the child is asked to press the key symbol identical with the one pictured on the screen beneath ***t.*** A wrong answer—other response symbols under ***a*** or ***n,*** for example—and the program would not advance.

In the audio-visual machine developed by Peter Goldmark and now being tested for reading readiness and elementary reading instruction in a Washington, D.C., pre-school, this slide is accompanied by a narration: "The word child *starts with the* ch *sound. The word* chain *starts with* ch, *too. . . . Now look down over the keys and say the names of the pictures. . . . Say* chair . . . *say* table. . . . *Push the key under the picture of something that starts with the* ch *sound." The program in which this slide is included inculcates auditory discrimination; the frame described in the text (see below) inculcates visual discrimination.*



The machines furnished by CBS are adaptable for seven different code patterns; so it is theoretically possible for children to find, and mimic various combinations of correct responses. However, field experience indicates that children don't tend to memorize answer-codes and that it is therefore not necessary to take elaborate measures to foil parrot-like responses.

The field trial of Dr. Goldmark's CBS machines functions within the framework of the National Capital Area Child Day Care Association, funded by O.E.O. The chief objectives of the courses, one written in Initial Teaching Alphabet and another in traditional orthography, are visual recognition of graphemes, auditory recognition of the corresponding phonemes, and formation of letter-sound associations. In addition, youngsters are encouraged to think through progressively more difficult discriminations based on both sound and sight, to synthesize separate sounds into words, and to analyze whole words into their separate sounds.—*Mildred Cleaves*

Cambridge Journal

Can the Third Arm Stop Pollution?

Lois Pines of Newton, Mass., ran for state representative last November and wanted to show she could do something about the environment. So Lois Pines formed a citizens' group and promised to clean up the town incinerator. Months have passed, and the case cannot even get into court. The reason: under current Massachusetts law, she and her group have no legal "standing" to bring suit against the town.

Governor Daniel J. Evans of Washington, a dedicated conservationist fed up with legislative inaction on his 1970 environment program, went on television for 15 minutes; he caused 5,111 voter telegrams to flood legislators, and six of his seven tough proposals were passed immediately. One is the toughest oil spill liability law in the country, which holds oil companies and tanker owners liable for unlimited expense of cleanup and damages—*even if they are not negligent* in causing the spill.

Can the taxpayer and citizen stop a polluter by going through that third branch of government—the courts?

In a startling number of states across the country, the answer is probably not. Strong, clearly worded legislation against specific polluters, such as Governor Evans' oil spill law, is a rare exception to our untidy mass of local and federal antipollution laws.

Damage under Common Law

Under common law, a citizen can bring suit only if he can prove he has suffered specific damages to himself or his property as a result of some act by a polluter.

◇ He might be able to prove trespassing against a polluter who has, say, dumped trash on his property, thus lowering its value. He might force the polluter to stop trespassing by seeking an injunction. He also might force the polluter to pay damages.

◇ Common law has considerable precedent for defense of a property owner's right to the enjoyment and use of his property. If a polluter interferes with this activity, he might be prosecuted on the grounds he is causing a "nuisance" to the owner. This situation might bring relief or damages in the case of kennel smells or airport noise.

◇ In a third type of suit under common law, a citizen can claim he has suffered damages thanks to the negligent performance of the polluter. If the town of Newton could have been shown to have operated the incinerator negligently—thus causing the soot to dirty residents' laundry and automobiles—the Pines group would have had a chance.

"Law school curriculums are showing a change. Now about 100 seminars in environmental law are being offered. Environmental-law tomes are being written and published. Environmental law students are getting very active. The big law firms are getting involved," said Malcom Baldwin, counsel for the Conservation Foundation in a New York Times *interview. Mr. Baldwin believes in the value of legal action in defense of the environment. "Litigation," he says, "whether it wins or loses, can draw public attention to vital issues."*

But these are indeed roundabout ways of halting construction of a power plant or preventing a hospital from dumping sewage into a town's river. The key weakness is *standing.* Lois Pines and her citizens group could not *themselves* prove specific harm had been done by the town incinerator. The only people with *standing* who could go to court were the residents of the neighborhood who could prove damages resulting from the negligent operation of the plant.

A "Private Right of Action"?

Proposals to release the parties bringing suit from proving they have suffered a "specific loss" are gaining currency among legislators, lawyers, and private citizens. The Massachusetts solution—proposed only—is a "private right of action" bill which enables a private citizen to sue whenever he feels some activity is damaging the environment. New York's is an "environmental bill of rights" which would accomplish virtually the same thing.

Reasonable as these proposed solutions appear at first blush, they are open to serious, rational objections. One reservation is the possibility that the courts would be flooded with citizen suits in any state which passed either measure; another reservation is that the private citizen may not be the best judge of the public good.

Professor Frank P. Grad of the Columbia University Law School summarized his feelings to a hearing on pollution law last December this way: "A private individual's interest may actually run counter to the general public interest." Should, for example, a farmer employing three people be able to shut down an upstream mill contaminating the water—but also providing employment for two-thirds of the area's population?

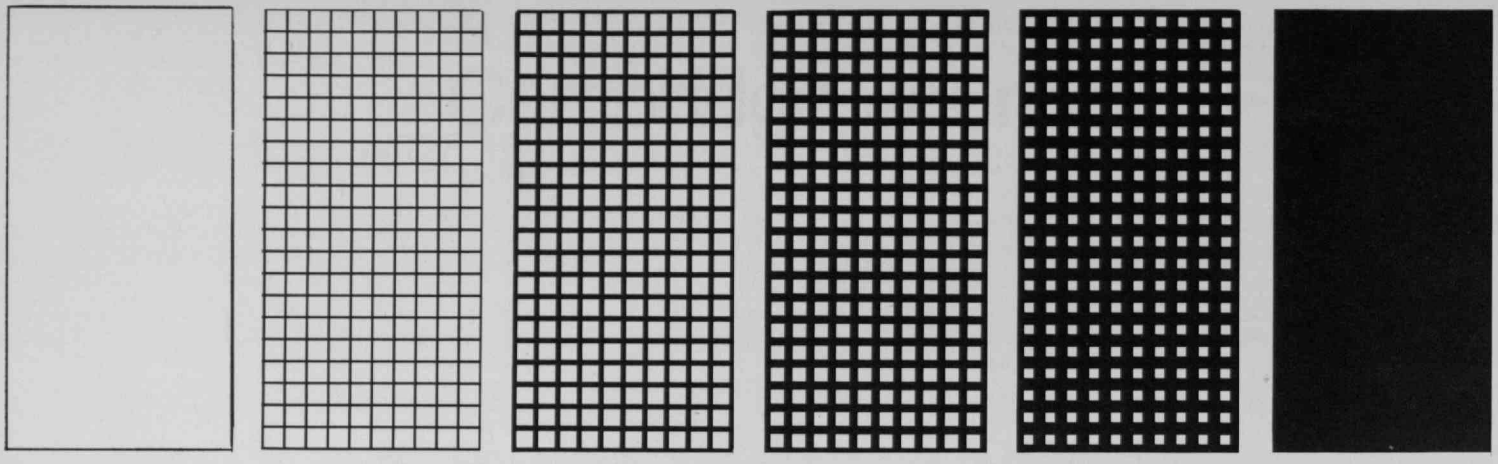
A related problem of rewriting common-law legislation, explains Thomas Arnold (of Kaplan, Sallowway and Epstein), the lawyer consulted by Mrs. Pines, is that no one—not the executive, legislative, or judicial branches of government or for that matter the public—is certain as to who should bear the principal cost of cleanup. It is unreasonable, says Mr. Arnold, to expect the courts to systematically put companies out of business—as would happen in Professor Grads' factory case. But the only alternative here is the imposition of a heavy fine, which doesn't stop the pollution.

Overall, then, the law appears to reflect a fundamental factor behind our continuing environmental crisis: public and corporate—let alone judicial—confusion about goals, means, and costs.

Public Interest and "Charity"

Last October, the Internal Revenue Service suspended issuance of tax exemptions to organizations of lawyers that bring actions in the name of the public toward objectives like pollution prevention and control. (Also at issue were the protection of consumers, the requirement of public service by broadcasting, and civil rights suits.) Little more than a month later, the I.R.S. recanted, deciding "that public-interest legal action would be accepted as charitable as long as it was *not* a cloak for lobbying or for service to private interests," in the words of McGeorge Bundy, President of the Ford Foundation, in the Foundation's 1970 Annual Report. Mr. Bundy praised this action by the I.R.S. as one that "recognizes the growing role of legal process as an instrument of social change and leaves the definition of the range of this instrument to the law and the courts."

In public-interest fields such as environmental defense, lawyers "may find it easier to help prevent something bad than to insure the achievement of something good," Mr. Bundy said. "Moreover, while it is often right to discount the irritation of the large corporation whose plans are upset by an unwanted lawsuit, there is no reason to suppose that any class of lawyers is wholly free of the vice of litigious excess. Courts and legislatures can be expected to react against such litigiousness if it becomes generally believed that public-interest law is trying to do too much. But for the present that is not the danger." The conclusion to which the I.R.S. came, he said, "gave public-interest law a general endorsement as legitimately charitable, which it had never had before."



How to Fight Pollution and Make Money

Despite the difficulties of government regulation of pollution by private industry, there are signs that industry itself is getting the message: efforts to reduce pollution are absorbing a good deal of capital expenditure as well as public relations efforts.

A good indication of the turnabout of industry attitudes is that many small companies which aim to offer technical advice on how to clean up—companies founded when the environmental bandwagon started rolling a year or two ago—are beginning to do good business.

Indeed, a new industry is emerging, and technically based companies that can serve as cleanup managers, consultants, analysts, and expert witnesses are proliferating. A recent estimate held that Pittsburgh alone has 300 firms making pollution control equipment. The trend is unmistakable.

One such company is Environmental Research and Technology, Inc., of Waltham, Mass., founded by two M.I.T. meteorologists in December, 1968, to consult on problems of air pollution as well as more typical meteorological work such as remote sensing of atmospheric data. By December, 1969, E.R.T. had accumulated six employees and had turned over $30,000 worth of business. By December, 1970, the business had passed the $100,000 mark. This year contracts have come in totalling $250,000. Norman E. Gaut, Vice-President for Technical Operations and one of the founders, explains: "Many of the areas we work in are beginning to gel. The efforts of the federal and state [government] and some cities have come along far enough to make a market for the type of services we have."

What if the public furor about pollution dies away? Will pollution abatement companies survive the end of the fad? They think they will, because even if the public interest fades the regulations will still be in force, and those industries that have met the regulations intend to keep an eye on competitors who haven't. The *Wall Street Journal* has

Enforcement: Too Many Fish in the Sea

Law enforcement agencies throughout the country know of many more alleged violators of the law than they can possibly investigate—let alone bring charges against. This is true even of the federal attorneys who represent the U.S. Department of Justice in each state. And it is surely true in the case of environmental protection.

The 1899 Refuse Act requires anyone who dumps anything into a river to first obtain a government license. Since not one license has been issued, in New York state alone there are presumed to be hundreds of thousands of violators —both large and small—of the 1899 Federal Refuse Act. It was under this Act that U.S. attorneys in New York's Southern District went after the biggest fish in their sea in December—General Motors, the world's largest corporation. Although they won the case, they lost a staff member in the process, and the Attorney General of the U.S. himself was sooted with charges of political interference.

On December 10, General Motors was charged with dumping chromium and aluminum, and "possibly" lead, copper, and mercury, into the Hudson in the form of paint residues from its plant in Tarrytown, N.Y. These wastes are said to enter the food chain through a crustacean water flea, *daphnia magna,* which grazes on algae and is eaten by fish. The fish were believed to be passing the harmful metals on to larger fish, birds, and perhaps humans consuming them. Twenty-four days later, G.M. agreed to a "consent decree"—a contract between the courts and the accused—which bound G.M. to stop dumping the wastes and cart them out by tank truck instead (until July 1, 1971). Part of the agreement was that General Motors finish building a treatment plant for these wastes—begun four years ago—by the end of the year.

The suit brought against G.M. was later said to be "soft" because the charges filed by U.S. Attorney John M. Burns, III, were only civil—not the dual civil-criminal charges he had obtained late last year to use against a smaller Hudson polluter, Standard Brands, Inc. Moreover, 15 minutes after Mr. Burns emerged from the negotiations which successfully brought G.M. to "heel," he was fired.

Burns told the press that Attorney General John Mitchell had used political pressures to soften the case against G.M. He also said that politics had prevented him from obtaining the tougher, dual civil-criminal charges he had sought in the first place. And, while high Justice Department officials denied that the Attorney General had any role in the G.M. case whatsoever, they did say that, when Mr. Mitchell read a press account of Burns' charges against him, "independently, the Attorney General found himself concurring with Seymour's [the man who fired Burns] opinion."

The grids to the left represent the air pollution potential of smoke as judged on the Ringlemann Scale, the basic smoke measurement technique used by many air pollution regulatory bodies. A nineteenth century method devised decades ago by the U.S. Bureau of Mines, the Ringlemann Scale used out in the field is a double bit of wood or cardboard holding a number of transparent plastic windows which are graded by opacity. It must be used under proper viewing conditions (on a clear day). The pollution danger of an emission is judged by the color of the smoke examined—the blacker the smoke, the worse the rating. Unfortunately, condensed oil from asphalt manufacturing plants, metal stamping plants and grinding and crushing machines in cement plants emit some noxious gases that do not rate badly on the Ringlemann scale, although they are believed to be far more damaging to health than many kinds of black smoke. Equally unfortunate is the fact that no portable, relatively easy to use alternate technology for judging the damaging possibilities of smoke emissions has so far been devised.

Lost in the furor over who had done what to whom, was the fact that General Motors had agreed to clean up at Tarrytown. True or not, the allegations and hassle show how hard it is—and may continue to be—to enforce reasonable standards of clean water.

But Big Fish Have Their Problems, Too

Even if you were a large (polluting) industry, and you wanted to clean up, you probably couldn't do it legally.

The bureaucracy now charged with some sort of regulation is labyrinthine. A small, 11-acre town pond in Rockland, Mass., for example (*see* Technology Review *for December, 1970, p. 70*), is under inspection by four state agencies. An Akron manufacturer says five different air pollution agencies claim jurisdiction over the pond. Bethlehem Steel's Bethlehem, Pa., plant recently trekked to three state agencies plus the Army Corps of Engineers for approval of a cleanup plant.

Pollution regulations in most state and federal agencies have three components: standards, deadlines, and penalties. In addition, they usually have the tool of negotiation—except where the specific standards and schedules are written into the law itself.

◊ *Standards.* Standards vary, from agency to agency and from state to state, forming an obstacle course for the national corporation that wants to clean up. The Rockland pond had not only four agencies watching it but four separate standards by which overall pollution was being measured. Can't a polluter satisfy the toughest standard and be safe? Not so. Different agencies can measure pollution in pounds of pollutants per hour, percentage of pollutant removed, percentage of pollutant remaining in the air or water, and even the color of the air itself. A control system which satisfies some of these may fail on others. And, of course, the numbers written into these standards are often changed.

◊ *Deadlines.* Deadlines, like standards, change with public pressure, new legislation, and increased technical knowledge. The best publicized recent example is the allegedly "impossible" deadline imposed by Congress for 1975 automobile exhaust emissions, in the 1970 Air Quality Act. Three times in 1970 before enactment of the Air Quality Act federal officials changed the way they said they would measure exhausts or the amounts of pollutants allowed. The *Wall Street Journal* quoted one Ford official as grumbling; "It's like the eighth inning of a ball game and someone changes the rules and the scoring system on you. . . . All we ask for is a simple, unchanging target to shoot at, and some order while we try to hit it."

quoted one company official whose plants will all meet regulations by the end of the year: " 'Surveying a list of competitors who haven't done as much at their own installations,' he grins, 'Yes, we'll sure be watching them to see that they comply with the codes, too.' "

Role of the Scientist

Most forms of pollution have been with us for at least twenty—if not a hundred—years. Yet there is amazingly little agreement among scientists and engineers about how the ecosystem works, and how best to manage it.

Not only have cities been dirtied, but the reputation of science has been sullied too, as expert witnesses with equally impressive credentials are increasingly asked to face each other, arguing opposite sides of a supposedly technical question before lawmakers and rate setters.

A case in point is a technical hearing before the Lake Michigan Enforcement Conference—the group charged with averting the slow death of Lake Michigan by coordinating policies and interests of the four states along its shore line. When called upon to testify, the experts simply could not agree on the effects of heat wastes added to the lake. Scientists for industry said aquatic life wouldn't be harmed because fish could swim away from hot areas; while the government's scientists insisted there would be a good chance of massive fish kills—sure sign of a dying lake.

A *Wall Street Journal* reporter wrote: "The debate, in short, was a standoff, with more questions being raised than answered. It could have been dismissed as an interesting educational demonstration of the inconclusive nature of scientific evidence—except that the issue is anything but theoretical." As a result of the standoff, "more indecision and further delay are possible," he wrote, while "another of the country's major lakes and natural resources may be slipping farther out of reach."

◇ *Penalties.* Lawmakers must specify in every law the permissible limits of punishment for those who violate it. But in most pollution laws the maximum fines specified are fairly low, so low they often undermine the incentive to clean up because pleading guilty is the best economic alternative for most companies. Some of the world's richest oil companies, for example, who had failed to install antispill devices in wells off the Louisiana coast, risk an upper limit of $2,000 per day for each day of violation. By oil company standards, it's not much. Jones & Laughlin Steel Corp. beat a charge of water pollution for its Aliquippa, Pa., plant by pleading guilty and being fined $1,000.

The government prefers to halt pollution by large corporations through negotiation—with the threat of court action or new, tough legislative proposals as a trump card. In November, for example, John T. Middleton, Commissioner of the National Air Pollution Control Administration (N.A.P.C.A.), which has no formal authority to stop them, asked the nation's airlines to voluntarily stop dumping fuel into the air after takeoff. This practice is estimated to cause 6,700 tons of fuel to befoul the air around airports every year. The meat of the request was that N.A.P.C.A. could threaten tough legislation—with all the ensuing bureaucratic and technical problems described above. N.A.P.C.A. claimed this technique was successful. The airlines will reduce fuel discharges voluntarily.

Moored beneath a famous Kenmore Square landmark in Boston, the air pollution monitoring station shown above is in continuous operation. Since late 1968, the Massachusetts Bureau of Air Use Management has been monitoring air pollution in Boston's Back Bay.

This station is equipped to monitor SO_2, CO, NO_2 (a main ingredient in photochemical smog), and ozone. In addition to monitoring suspended particulates, equipment also includes a hydrothermograph for keeping track simultaneously of temperature and relative humidity. Equipment to monitor organic compounds from photo oxidation of hydrocarbons is planned.

In the fall of 1968, this monitoring station detected levels of 0.116 ppm of SO_2 in Kenmore Square—one of the city's "dirtiest" air sections. In the fall of 1970, the SO_2 level was 0.061 ppm. The Department credits this improvement to the ban on open burning, the limitations on sulfur content of fuel, and strict enforcement of smoke emission regulations. Further improvements in Back Bay air quality are expected by the B.A.U.M. as a result of newer regulations which are expected to bring the annual value down below 0.030 ppm.

Air Pollution and the State Agency: "Practical Air Use Management"

The following text is based on an interview with James L. Dallas, Director of the Bureau of Air Use Management (B.A.U.M.), Division of Environmental Health, Massachusetts Department of Public Health—the agency charged by law with air pollution abatement and control in the Commonwealth. The Bureau consists of the Ambient Air Monitoring Section, Data Handling and Evaluation Section, Industrial Control Section, Incinerator Control Section; Fossil Fuel Combustion Section, and six Regulation Enforcement Districts. The Bureau is funded by the federal and state governments, each contributing approximately half of the budget, and has a staff of about 60 people.

"One of the most difficult tasks in a good air use management program," Mr. Dallas says, "is that of determining the proper balance between control of contaminating sources and reasonable use of our air as a natural resource. That's why we are an air use management agency and not just a pollution control agency. Air exists as a self-perpetuating resource because of its varying capacity to receive and disperse limited amounts of contaminants." Statements like these have brought sharp criticism from some quarters, by people who say that the B.A.U.M. approves of pollution. But Mr. Dallas attributes to these critics a failure to understand the concept of "proper balance."

In Massachusetts, a contaminant is not considered a pollutant unless it is present in such quantities—either by itself or together with other contaminants—that it becomes a nuisance or can cause injury to health, vegetation, wildlife, or property. The B.A.U.M. uses this distinction to point out that in their view air is a resource that may be used, but not abused, by man and that there are concentration levels of some contaminants in the air which "with proper air use management can be beneficially tolerated without adverse effects" for man or his environment.

This point of balance should be "determined for the maximum benefit of our whole society," said Mr. Dallas, "but to determine this proper balance between use and abuse, the state must not only be a good custodian of its air, it must also educate the public, determine and publicize bad effects of air pollution, and donate the effort and time required to solve pollution problems. The courts must also be educated in air pollution matters so that they can act judiciously in cases involving the 'reasonableness' of enforcement measures. 'Contaminators' of the environment must act responsibly and be held accountable for their actions. Elected officials must act as statesmen and not as political opportunists," and, he said, "control officials need good judgement and foresight to guard against attempts to do too little too late, or too much too soon."

"It is my belief," Mr. Dallas said, "that all concerned parties (including the public) have a responsibility to become acquainted with the state of the art of air pollution control, the real significance of air contamination, and the benefits versus the risks of air contamination, controlled or uncontrolled, before making potentially unreasonable demands upon each other. The effectiveness of a program should not be measured by the number of dollars collected in fines, the number of people taken to court, or the number of businesses (thus jobs) removed from the economy."

Rather than demand immediate compliance through court action or other measures, and so shut down existing plants, the B.A.U.M.'s official policy is to first "encourage" them to make satisfactory adjustments in plant and equipment, while demanding that new facilities be designed to meet regulations from their initial day of operation. This applies to schools as well as industrial plants, and other large facilities. "We've had some school architects in here with tears in their eyes accusing us of making schools look like factories; but this is not so, we are simply making factories look like schools," said Mr. Dallas.

Determining Standards

"One problem in implementing a *reason-*

Ambient Air Quality Standards

Contaminant	Duration of Concentration	Proposed Federal Average concentration Primary standard μg./cu.m.	p.p.m.	Secondary standard μg./cu.m.	p.p.m.	Explanation	Extant Massachusetts Average concentration μg./cu.m.	p.p.m.	Explanation
Sulfur oxides (SO_2)	Year	80	0.030	60	0.023	Arithmetic mean	73	0.025	Arithmetic average of four consecutive seasonal geometric means
	Day	365	0.137	260	0.097	Maximum	300	0.105	Maximum
	Hour	—	—	—	—	—	800	0.280	Maximum
Total suspended particulates (TSP)	Year	75	—	60	—	Geometric mean	75	—	Arithmetic average of four consecutive seasonal geometric means
	Day	260	—	150	—	Maximum	180	—	Maximum
Carbon monoxide (CO)	8 hrs.	10 mg.	8.6	Same	Same	Maximum	9.2 mg.	8	Maximum average during any 8-hr. period
	1 hr.	15 mg.	12.8	Same	Same	Maximum	—	—	—
Photochemical oxidants (O_3)	1 hr.	125	0.063	Same	Same	Maximum	120	0.06	Maximum average during any 1-hr. period
Hydrocarbons (non-methane)	3 hrs.	125	0.188	Same	Same	Maximum between 6 and 9 a.m.	120	0.18	Maximum average during any 3-hr. period
Nitrogen oxides (NO_2)	Year	100	0.052	Same	Same	Arithmetic mean	—	—	—

able use philosophy is that of determining what the limiting levels of contamination should be," said Mr. Dallas. "The standards the Department of Public Health adopted for Massachusetts bend over backwards on the side of safety. They represent the lowest possible levels at which a reputable researcher thought health effects might have been observed. The numbers in these standards were chosen in light of *present* knowledge of appropriate tolerance factors and the *current* state of the art in air quality monitoring and control technology. They all contain built-in safety factors which place them about 10 per cent below the lowest measured adverse effect listed in the federal criteria. Air quality compatible with these standards *will* protect the public health. These tolerances were chosen with the knowledge that they could be changed as the need became apparent or prudent." (The proposed federal and present Massachusetts ambient air quality standards appear above.)

Boston's Air Is Improving

Contrary to the opinions of critics, Mr. Dallas states that "the air over Boston *is* getting cleaner." To support this claim he quotes the fall (1970) averages at the John F. Kennedy Building sampling station in Government Center, Boston, as 0.017 p.p.m. for SO_2 and 71μg./cu. m. for particulates. (For Kenmore Square figures see caption page 72.)

While the opposition—notably those who feel that "encouragement" under threat of court action rather than legal coercion after initial failure to comply is a "do-nothing" policy, particularly when applied to industry—is airing its complaints, Mr. Dallas lets it be known that he has some complaints too. Among them are "inaccurate reports" by some news media; "the patriarchal attitude on the part of the Federal Government and Washington bureaucrats"; petitions by "ill-advised and misinformed legislators and citizens"; and "earlier-day failures" to gain necessary budgetary support for air use management programs.

On this last, he says he has become "philosophical" and that he "realizes that there is great competition for the tax dollar of John Q. Citizen and that many other programs have priorities considered higher than ours." (The B.A.U.M. currently operates with only 30 per cent of the manpower the Federal Government says it needs to do the job.) But he is "particularly unhappy" at the failure of those interested in clean air and environmental quality to recognize that "the people's one big problem is too many people." He thinks that applying technological solutions involving hardware and mechanical systems, will not, by itself, be enough to neutralize "man's environmental input." What we need, he believes is "to define a total environmental system involving man that is attainable *and* worthy, not just expedient, even though such may require population management and affluence control. . . . Affluence is, after all, somewhat government regulated for economic reasons. Why," he asks, "do we ignore its effect upon the environment?"

"I am confident," Mr. Dallas concluded, "that the public will soon separate fact from fancy. And when it stops reeling from propaganda assaults on its emotions, it will demand good, objective air use management programs—free from panic—to insure a quality of ambient air compatible with its wishes."

Tech-Crostic
David L. and Judith G. Holt

Wooden Shoes and Sailor's Stews

		H 1	K 2	Q 3		W 4	Y 5		L 6	C 7	N 8	S 9	H 10	F 11	B 12	M 13	R 14	E 15	K 16	P 17	I 18		Z_1 19
X 20		C 21	N 22	W 23		Z_1 24		K 25	M 26	W 27	L 28	A 29	V 30		I 31	F 32	K 33	V 34	D 35	O 36	T 37	Q 38	
W 39	X 40		M 41	P 42	F 43	Z 44	K 45	R 46		Z 47	X 48		R 49	K 50	I 51	C 52	L 53	P 54	S 55		I 56	U 57	Z_1 58
O 59		K 60	L 61	Z_1 62		Q 63	J 64	E 65	K 66	W 67		M 68	Q 69	O 70	A 71	J 72	U 73	W 74	F 75		K 76	H 77	C 78
S 79	N 80	M 81	Z 82		X 83	Z_1 84		B 85	V 86	G 87	E 88	Q 89	C 90	S 91	H 92	P 93	Z_1 94	R 95	B 96		I 97	N 98	C 99
O 100	K 101	E 102	M 103	S 104		A 105	Y 106	O 107		J 108	O 109	E 110	W 111	B 112	K 113	Q 114	G 115	U 116		W 117	G 118	U 119	
S 120	C 121	R 122	U 123	D 124	L 125	I 126	M 127	F 128	P 129		T 130	W 131		O 132	I 133	K 134	B 135	R 136	D 137	L 138	M 139	Z 140	Q 141
H 142	E 143	S 144		T 145	J 146	O 147	V 148	K 149		K 150	F 151	C 152	P 153	R 154	U 155	S 156		M 157	X 158	W 159		V 160	L 161
G 162	J 163	Q 164	T 165		X 166	W 167		M 168	H 169	B 170	P 171	C 172	F 173	S 174	N 175	E 176	K 177	X 178		Y 179	V 180		C 181
W 182	M 183	Z_1 184		N 185	K 186	G 187	Y 188	P 189	X 190	F 191		R 192	N 193	D 194	X 195		T 196	Y 197		E 198	W 199	U 200	V 201
N 202		R 203	J 204	X 205	O 206	L 207	C 208	F 209		M 210	X 211	Z 212		Z 213	W 214	P 215	E 216	A 217	U 218	N 219	X 220	G 221	B 222
	X 223	L 224	J 225	Y 226	Z_1 227	C 228	Q 229		V 230	S 231		U 232	V 233	Y 234		W 235	Y 236	B 237	I 238	S 239	P 240	V 241	C 242
E 243	H 244	T 245	L 246	U 247	X 248	J 249	D 250	A 251	Z_1 252		X 253	S 254	E 255	C 256	I 257	Z 258	B 259	W 260	K 261	T 262			

Use the definitions at the right to help define the words to which they refer; then enter the appropriate letters in the diagram to complete a quotation from a scientific work. The first letters of the defined words give the author and title from which the quotation is taken. Black squares in the diagram indicate the ends of words; when there is no black square at the right end of the diagram, the word continues on the next line.

The correct solution to this Tech-Crostic will appear in the June issue of *Technology Review*.

David L. Holt is Assistant Professor of Metallurgy at M.I.T. He will welcome readers' comments; address him in care of *Technology Review*, Room E19-430, M.I.T., Cambridge, Mass. 02139.

A. Wooden shoe; attachment to a projectile.

71 29 105 217 251

B. Sailor's stew.

96 12 170 135 85 259 237 222 112

C. Humorous personification of whiskey (2 words).

52 7 121 90 21 99 152 181

228 242 256 78 172 208

D. Notification; dispatch boat.

194 35 137 250 124

E. The muscle sense.

198 110 15 88 143 216 65 255

102 176 243

F. Study of fossil footprints.

11 32 151 173 43 75 128 209 191

G. Merry; joyous; cheerful.

87 115 187 221 118 162

H. Purify; make (a current) unidirectional; determine the length of (an arc).

77 142 10 92 244 1 169

I. Instrument superceded by the sextant. 31 18 257 238 133 56 97 51 126

J. Inferential. 72 146 204 225 64 249 163 108

K. City in Northumberland, England (comp.). 134 16 186 177 60 149 33 45 261
50 76 2 113 150 101 25 66

L. Mineral of the feldspar group. 125 161 6 28 138 224 246 207
61 53

M. Receive into some other part or thing. 103 127 210 139 81 41 13 183
168 26 68 157

N. Corrugated iron shelter (2 words). 8 219 202 185 80 98 193 22 175

O. Descending slope. 206 59 132 100 36 109 147 107 70

P. Having a strained condition of the eyes. 215 17 189 42 171 129 153 240
93 54

Q. Wind blowing from the north. 141 63 3 114 69 164 89 229 38

R. Arranged in pairs each at right angles to the next; cut in the form of an X. 46 122 136 154 49 14 95 192 203

S. Wardrobe. 79 254 239 55 156 91 144 120
231 174 9 104

T. Bone formation. 130 165 37 245 145 196 262

U. Originating in or produced by muscle or muscle tissue. 218 116 247 155 119 123 200 232
57 73

V. Love of wisdom 148 241 34 30 230 160 180 201
233 86

W. Having no distinct character; undistinguished. 27 235 260 4 131 167 159 67 182
214 23 39 74 117 199 111

X. Lack of consideration. 83 211 166 205 248 158 40 190 48
20 178 195 253 223 220

Y. Emanating; having issue. 234 5 188 226 106 236 179 197

Z. Variety of quartz stained deep red. 258 44 47 213 140 82 212

Z_1. Examination of the refractive state of the eye by a device which observes the retinal lights and shadows. 184 58 19 24 252 94
84 227 62

The "Most Impressive" Solution

Yesterday I gave an examination to my calculus class which was supposed to last 1½ hours. After 2½ hours the last unhappy students finally left. Today in class I had to face them personally. As a result, I feel quite guilty about wasting other people's time; so for a change, I'll be brief.

The current backlog is rather large (some problems used this month were submitted last July), so please be patient. I am sincerely flattered by the response this column has received. I must have over 100 letters in front of me now, and it is nice to feel wanted.

Problems

Our bridge problem for this month is from Edwin G. Davis:

31 South has rashly bid six spades:

	♠ 2 ♥ A Q 10 9 8 7 ♦ A K Q ♣ J 3 2	
♠ 6 5 4 3 ♥ K J ♦ 8 7 ♣ K Q 10 9 4		♠ 10 9 8 7 ♥ 6 5 4 3 2 ♦ 6 5 4 3 ♣ —
	♠ A K Q J ♥ — ♦ J 10 9 2 ♣ A 8 7 6 5	

How can South make the contract against a spade lead?

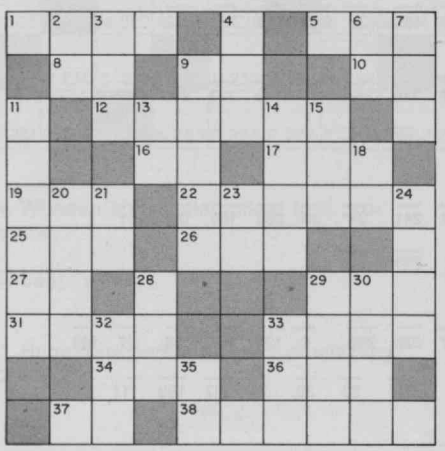
32 Norman L. Apollonio wants you to prove that a regular icosahedron having the same volume as a regular dodecahedron has the same perpendicular distance from the center to a face.

The following game, submitted by John E. Prussing, was discovered by David L. Silverman:

33 Two players play a game in which each player alternately selects dates of the year subject to the restrictions: (1) The first date must be in January, and each subsequent selection must (2) agree with the immediately preceding date in either month or number and (3) be later in the calendar year. The winner is the player who is able to select December 31. Which player has the advantage and what is the winning strategy?

John Mandl sent a copy of this problem to the Editor of the Journal of the Society of Aeronautical Weight Engineers; only two solutions have come in from a readership of 1,000 members. So here's our chance to beat the S.A.W.E. at their own game:

34 The problem is to determine the total quantity of vehicles (both types A and B) purchased (horizontal 5). It is known that the center of gravity (CG) of type A vehicles is identical to the center of gravity of type B vehicles. The customer bought some A vehicles and some B vehicles. All values are positive whole numbers. There were 46 charter members of S.A.W.E. Use the speed of light as 186,284 mi./sec., and 4,633 lb. in. sq. per slug ft. sq. There is one unique solution, requiring only basic mathematics, some logic, and a lot of ingenuity.



Horizontal:

1. Weight of vehicle A.
5. Total quantity of vehicles A and B purchased.
8. Sum of digits of 22 horiz. and 11 vert.
9. Robert's age.
10. Age of the second Fred in Robert's family.
12. Total cost of vehicles A and B purchased.
16. Sum of the ages of the three Freds in Robert's family.
17. CG of forward section of vehicle B.
19. Weight of aft section of vehicle A.
22. Moment from station O of vehicle A.
25. Unit price of vehicle A.
26. Weight of forward section of vehicle A.
27. Weight-reduction ideas considered, but not implemented, for vehicle B.
29. Non-prime number.
31. Next in series 7, 6, 5 . . .
33. Product of the ages of the three Freds.
34. Weight of vehicle B.
36. Unit price of vehicle B.
37. Age of eldest Fred.
38. Moment from station O of vehicle B.

Vertical:

2. Cost-increase weight-reduction ideas implemented in vehicle B.
3. CG of vehicles A and B.
4. CG of aft section of vehicle A.
6. Cost-decrease weight-reduction ideas implemented in vehicle B.
7. CG of aft section of vehicle B.
9. Robert discovered that when his name was arranged as a division problem, there were four numerical solutions:

ENNIS
J) ROBERT

One quotient is 311 - - .

11. Speed of light (*).
13. Greater than 60.
14. Greater than the square of the age of the eldest Fred.
15. Total weight-reduction ideas considered for vehicle B.
18. LXXVI.
20. Lb. in. sq. per slug ft. sq.
21. No-cost-change weight-reduction ideas implemented in vehicle B.
23. Robert's age. He is 12 years older than the middle Fred.
24. Square of the number of charter members of S.A.W.E.
28. Quantity of vehicles B purchased.
29. Square of atomic number of krypton.
30. Year of election of the 70th U. S. Congress.
32. Weight of forward section of vehicle B.
33. Decimal equivalent of the binary 10,000,011.
35. Prime number.

It seems unlikely to me that anyone but the proposer, Preston Bush, will solve this one, but I've been wrong before:

35 Given the following sequence of numbers:
1,2,1,3,2,1,2,3,4,1,2,1,3,2,1,2,3,5,2,3,4,1,4
3,1,4,5,2,3,1,5,2,1,2,4,6,1,2,1,4,2,1,2,6, . . .
find the method of formation. Of interest —though of little help in solving the problem—is where numbers first appear; for example, 5 first appears at the 18th position:

Number	Position of first appearance
1	1
2	2
3	4
5	18
6	36
7	67
8	94
9	148
10	178
11	301
12	337
13	452
14	606
15	612
16	736
17	986
18	1120

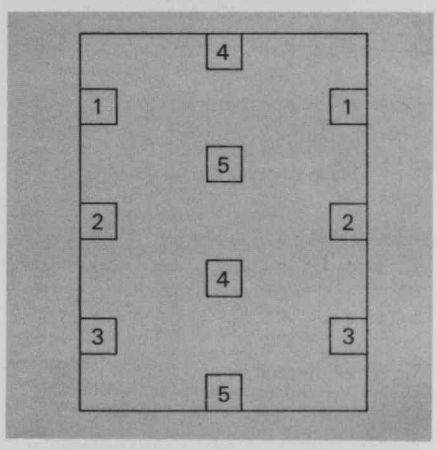
Speed Department

R. Robinson Rowe submits the following, a problem which he used in the 1940's to try to help some of his colleagues in the California Division of Highways prepare for the examination for professional registration, which suddenly became a requirement for advancement. Equations of energy and momentum led into quadratics—hence the problem:

SD9 Two balls approach head-on, Ball A eastbound at 10 knots and Ball B westbound at 15 knots; after colliding, Ball A is westbound at 20 knots and Ball B eastbound at 5 knots. Suppose the approach velocities had been 15 knots for A and 10 knots for B, what would have been their respective retreat velocities?

Here is a beauty from John P. Rudy:

SD10 Connect the pairs of points, 1 with 1, 2 with 2, etc., without crossing lines, going outside boundaries, or going within the eight little squares.



Solutions

16 Given the following hand:

	♠ Q x x x ♥ Q x x ♦ A K x ♣ K 9 x	
♠ 10 9 x ♥ A ♦ x x x ♣ A Q 10 x x x		♠ J ♥ K J 10 x x x ♦ J x x x ♣ J x
	♠ A K x x x ♥ x x x ♦ Q x x ♣ x x	

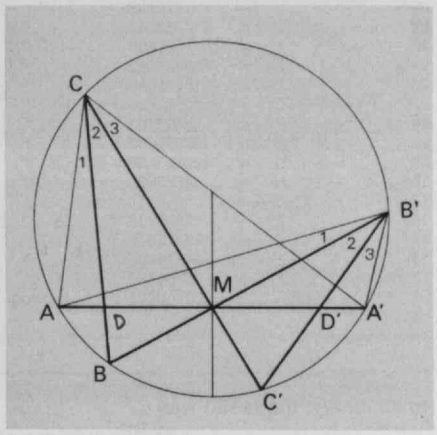
West opens with the ♥A and shifts to a low club. Can you make the contract—four spades?

The following is by Eugene D. Richter: In order to have a chance of making his contract, the declarer initially has no choice but to come up with dummy's ♣K at trick 2, followed by drawing three rounds of trumps. Five more tricks are then safely available in diamonds and trumps, for a total of nine tricks. The tenth trick is established either by a ruff or by setting up dummy's ♥Q. After clearing the diamond suit, a club is led from either hand. If West takes the trick with the ♣A or ♣Q, he must then return the other high club which the declarer permits him to hold by discarding a heart from the closed hand. Still in the lead, West must continue the ♣10 which is ruffed in dummy. This permits the final heart loser to be discarded from the closed hand, leaving it with two good trumps, thus securing the contract. If West plays low on the declarer's club lead, East wins the trick with ♣J. Assuming he has not discarded the 13th diamond, East might choose to lead it, but this would give the declarer a heart discard in the closed hand while ruffing the diamond lead in dummy. Dummy's ♥Q then falls to East's ♥K, and the closed hand claims the remaining two tricks in trumps. East's other option is to lead a heart which sets up dummy's ♥Q for the declarer's tenth trick. The losing tricks are either two clubs and a heart or two hearts and a club, depending on which defender takes the club trick.

Also solved by W. C. Backus, Richard A. Bator, F. Steele Blackall, III, Ed Gershuny, Winslow H. Hartford, Allen J. Huber, Michael A. Kay, John S. Larsma, John W. Meader, Frank S. Model, R. Robinson Rowe, Les Servi, Hugh D. Sims, P. J. Sullivan, and Eric Weitz.

17 Let the chord AA′ perpendicular to a radius of a circle intersect the radius in M. Let any other two chords through M intersect the circle in B,B′ and C,C′. Let BC and B′C′ intersect AA′ in D and D′. Show that MD = MD′.

The following elegant solution is by John T. Rule; he calls it "a beautiful example of the power of the cross ratio theorem":



This is the "butterfly" problem. It is quite difficult to prove by a straightforward Euclidian attack. The proof is, however, quite simple if the cross ratio theorem is employed. Two sheaves of rays C(ABC′A′) and B′(ABC′A) are congruent since the angles are respectively equal, as they subtend equal arcs. Hence transversals cutting these sheaves will yield point rows having equal cross ratios when taken in the same order. Consider the transversal AA′; we may write the equality of cross ratios as follows:

For sheave B, AD′/D′M ÷ A′A/AM =
For sheave C, A′M/DM ÷ A′A/AD.

Remembering that A′M = AM, this equality by cancellation will reduce to AD′/D′M = AD/DM.
But AD′ = A′M − D′M, and
AD = AM − DM, so
(A′M − D′M)/D′M = (AM − DM)/DM, or
(A′M/D′M) − 1 = (AM/DM) − 1,
and since A′M = AM, D′M = DM.

Also solved by W. M. Burgess, John L. Joseph, Mrs. Martin S. Lindenberg, Michael Rolle, R. Robinson Rowe, and F. H. E. Vose.

18 A railroad operates under the following conditions: 1. There is exactly one train per day to take passengers from any given suburban station to any other suburban station; 2. No two trains in the same direction have more than one stop in common; 3. Each train stops at exactly three suburban stations; and 4. More than one train per day in each direction stops at each suburban station. How many trains per day are there in each direction, and how many stations are there on the line?

The following is from Robert W. Baird: We can treat the problem as if trains travel in one direction only, since the number of trains in each direction must be equal. Call the number of stations n and the number of trains in a given direction t. By conditions 1 and 3, each train which stops at a given station must also stop at two of n − 1 other stations, and by condition 2 these trains have only the given station as a common stop. Thus (n − 1)/2 trains stop at each station, making n(n − 1)/2 total stops altogether and requiring n to be odd. By condition 3 again, there must be n(n − 1)/6 total trains. Therefore, there are an infinite number of solutions all satisfying the Diophantine equation: t = n(n − 1)/6 (n odd and n > 3); condition 4 eliminates the solution t = 1, n = 3. Two sample solutions:

If n = 7, t = 7, the trains stop at stations as follows:

Train 1: 1,2,3	Train 5: 2,5,7
Train 2: 1,4,5	Train 6: 3,4,7
Train 3: 1,6,7	Train 7: 3,5,6
Train 4: 2,4,6	

If n = 9, t = 12, the trains stop at stations as follows:

Train 1: 1,2,3	Train 7: 2,6,9
Train 2: 1,4,5	Train 8: 3,4,6
Train 3: 1,6,7	Train 9: 3,5,9
Train 4: 1,8,9	Train 10: 3,7,8
Train 5: 2,4,8	Train 11: 4,7,9
Train 6: 2,5,7	Train 12: 5,6,8

Also solved by Roger Milkman, Michael Rolle, and R. Robinson Rowe.

19 Rationalize the denominator of

$$\frac{1}{\sqrt[2]{2} - \sqrt[3]{3} - \sqrt[5]{5}}$$

or prove it impossible.

R. Robinson Rowe submitted the most impressive solution I have ever received. His *magnum opus* is reprinted below. A gold border would be fitting, but unfortunately my congratulations will have to suffice. Here is the answer:

The problem is to rationalize the denominator of a fraction or prove it impossible. The denominator is the algebraic sum of three surds. In general, it is possible to rationalize the sum of any number of surds by multiplication by its "rationalization factor" (RF). The RF may be complicated, as it may consist of as many as N—1 surds, where N is the product of the different indices of the given expression. Here the indices were 2, 3, and 5, so the RF could (and did) consist of 29 surds plus a rational quantity involving 30 coefficients ranging from 1770832 to 120355058. Determination of these values required the solution in integers of 29 equations in 30 unknowns. The detail of the solution is:

The problem is to rationalize the denominator of

$$\frac{1}{\sqrt{2}-\sqrt[3]{3}-\sqrt[5]{5}} = \frac{1}{r-s-t}$$

The procedure is to multiply both numerator and denominator by its "rationalization factor" consisting of 30 (= 2 × 3 × 5) terms, each consisting of a rational coefficient times a surd. The surds will be all possible combinations of the three given surds to powers less than the radical indices. To simplify typing, the given surds will be represented by r, s and t — as shown. The 30 coefficients will be represented by letters — unknowns to be evaluated. This rationalization factor will be multiplied by the given denominator, in a tabular array, deriving "product coefficients" for each of the surds. Each product coefficient will be equated to zero, so that the complete product will be the product coefficient of the rational unit. With just one rational unit, there will result 29 equations in 30 unknowns. These may be solved for 29 unknowns in terms of the 30th, or for all 30 in integers proportional thereto.

Rationalization factor terms		Product Coefficients				Eq No.
Coef.	Surd	·r	·s	·t		
A	1	2B	− 3D	− 5H	= den	(1)
B	r	A	− 3J	− 5N	= 0	(2)
C	s	2I	− A	− 5R	= 0	(3)
D	s^2	2J	− C	− 5V	= 0	(4)
E	t	2K	− 3S	− A	= 0	(5)
F	t^2	2L	− 3T	− E	= 0	(6)
G	t^3	2M	− 3U	− F	= 0	(7)
H	t^4	2N	− 3V	− G	= 0	(8)
I	rs	C	− B	− 5Z	= 0	(9)
J	rs^2	D	− I	− 5d	= 0	(10)
K	rt	E	− 3a	− B	= 0	(11)
L	rt^2	F	− 3b	− K	= 0	(12)
M	rt^3	G	− 3c	− L	= 0	(13)
N	rt^4	H	− 3d	− M	= 0	(14)
O	st	2W	− E	− C	= 0	(15)
P	st^2	2X	− F	− Ø	= 0	(16)
Q	st^3	2Y	− G	− P	= 0	(17)
R	st^4	2Z	− H	− Q	= 0	(18)
S	s^2t	2a	− Ø	− D	= 0	(19)
T	s^2t^2	2b	− P	− S	= 0	(20)
U	s^2t^3	2c	− Q	− T	= 0	(21)
V	s^2t^4	2d	− R	− U	= 0	(22)
W	rst	Ø	− K	− I	= 0	(23)
X	rst^2	P	− L	− W	= 0	(24)
Y	rst^3	Q	− M	− X	= 0	(25)
Z	rst^4	R	− N	− Y	= 0	(26)
a	rs^2t	S	− W	− J	= 0	(27)
b	rs^2t^2	T	− X	− a	= 0	(28)
c	rs^2t^3	U	− Y	− b	= 0	(29)
d	rs^2t^4	V	− Z	− c	= 0	(30)

Deductions:

Source						Eq. No.
3,2,26	2I	= 3J	+ 10N	+ 5Y		(31)
4,9,30	2J	= B	+ 10Z	+ 5c		(32)
5,27,2	2K	= 3W	+ 6J	+ 5N		(33)
6,28,11	2L	= 3X	+ 6a	+ B		(34)
7,29,12	2M	= 3Y	+ 6b	+ K		(35)
8,30,13	2N	= 3Z	+ 6c	+ L		(36)
15,11,9	2W	= 3a	+ 2B	+ 5Z		(37)
16,12,23	2X	= 3b	+ 2K	+ I		(38)
17,13,24	2Y	= 3c	+ 2L	+ W		(39)
18,14,25	2Z	= 3d	+ 2M	+ X		(40)
19,23,10	2a	= K	+ 2I	+ 5d		(41)
20,24,27	2b	= L	+ 2W	+ J		(42)
21,25,28	2c	= M	+ 2X	+ a		(43)
22,26,29	2d	= N	+ 2Y	+ b		(44)

So far, 15 unknowns have been eliminated, leaving 14 equations in 15 unknowns. Now substitute for B, L, W, a and b:

32	B	= 2J	− 10Z	− 5c		(45)
36	L	= 2N	− 3Z	− 6c		(46)
36,39	W	= 2Y	− 4N	+ 6Z	+ 9c	(47)
43	a	= 2c	− M	− 2X		(48)
44	b	= 2d	− N	− 2Y		(49)
33,47	2K + 7N = 6J	+ 6Y	+ 18Z	+ 27c		(50)
34,45,46	2J + 19c = 4N	+ 6M	+ 9X	+ 4Z		(51)
35,49	K + 3Y + 12d = 2M	+ 6N	+ 12Y			(52)
37,45,48	4J + 8N = 3M	+ 6X	+ 4Y	+ 27Z	+ 22c	(53)
38,49	2K + I + 6d = 3N	+ 2X	+ 6Y			(54)
41,48	2I + K + 2M	+ 4X	+ 5d = 4c			(55)
42,46,47	J + 8Y + 9Z + 12c = 4N	+ 4d				(56)

These seven with 31 and 40 make nine equations in 10 unknowns. Now substitute for I, K, Z:

2I = 3J + 10N + 5Y			(31)
2Z = 2M + X + 3d			(40)
K = 2M + 6N + 9Y − 12d			(52)
40,50,52	6J + 14M − 19N + 9X − 12Y + 27c + 51d = 0	(57)	6 equations in
40,51	2J − 10M − 4N − 11X + 19c − 6d = 0	(58)	7 unknowns;
40,53	8J − 60M + 16N − 39X − 8Y − 44c − 81d = 0	(59)	eliminate J by
31,52,54	3J + 8M + 28N − 4X + 29Y − 36d = 0	(60)	combination
31,52,55	3J + 4M + 16N + 4X + 14Y − 4c − 7d = 0	(61)	
40,56	2J + 18M − 8N + 9X + 16Y + 24c + 19d = 0	(62)	
57 − 2 × 61	6M − 51N + X − 40Y + 35c + 65d = 0	(63)	5 equations in
4 × 58 − 59	20M − 32N − 5X + 8Y + 120c + 57d = 0	(64)	6 unknowns;
60 − 61	4M + 12N − 8X + 15Y + 4c − 29d = 0	(65)	eliminate X by
62 − 58	28M − 4N + 20X + 16Y + 5c + 25d = 0	(66)	combination
58 + 2 × 62 − 2 × 61	18M − 52N − X + 4Y + 75c + 46d = 0	(67)	
4 × 64 + 66	108M − 132N + 48Y + 485c + 253d = 0	(68)	4 equations in
63 + 67	24M − 103N − 36Y + 110c + 111d = 0	(69)	5 unknowns;
6 × 63 + 64	50M − 287N − 192Y + 295c + 382d = 0	(70)	eliminate M by
8 × 63 + 65	52M − 396N − 305Y + 284c + 491d = 0	(71)	combination
69 + 12(70 − 71)	1205N + 1320Y + 242c − 1197d = 0	(72)	3 equations in 4
68 + 2 × 70 − 4 × 71	878N + 884Y − 61c − 947d = 0	(73)	unknowns; eliminate
2 × 70 − 71 − 2 × 69	28N − 7Y + 86c + 51d = 0	(74)	Y by combination
7 × 72 + 1320 × 74	45395N + 115214c + 58941d = 0	(75)	2 equations in 3
7 × 73 + 884 × 74	30898N + 75597c + 38455d = 0	(76)	unknowns; eliminate N by combination
30898 × 75 − 45395 × 76	128156357c + 75494293d = 0	(77)	GCD = 7 coefficients
77/7	18308051c + 10784899d = 0	(78)	relatively prime

	d	=	18308051	Take c and d as least integers satisfying 78
	c	=	−10784899	
75,76	N	=	3601201	Substituting back to derive other coefficients,
72,73,74	Y	=	15291845	testing each equation
68,69,70,71	M	=	3148973	"
63-67	X	=	−36110637	"
57-62	J	=	−18280543	"
52	K	=	−54164855	From substitution equations, testing 50-56
40	Z	=	12555731	" "
31	I	=	28814803	" "
49	b	=	2431211	" testing 31-44
48	a	=	47502503	" "
47	W	=	−5550819	" "
46	L	=	34244603	" "
45	B	=	−108193901	" "
30	V	=	1770832	From basic equations, testing all others
29	U	=	17723056	"
28	T	=	11391866	"
27	S	=	−23831362	"
26	R	=	18893046	"
25	Q	=	−32961664	"
24	P	=	28693784	"
23	Ø	=	−25350052	"
19	D	=	120355058	"
18	H	=	58073126	"
17	G	=	1889906	"
16	F	=	−46871222	"
15	C	=	−45415246	"
11	E	=	34313608	"
5	A	=	−36835624	"
1	Denominator	=	−867818606	From basic relation—not self-checking

Numerator = A + Br + etc. = $-36835624 - 108193901\sqrt{2} - 45415246\sqrt[3]{3} + 120355058\sqrt[3]{9}$ etc.

In summary, the result was

$$\frac{1}{\sqrt{2}-\sqrt[3]{3}-\sqrt[5]{5}} = \frac{-\text{RF}}{867\,818\,606}$$

in which RF is

$$-36835624 - 108193901\sqrt{2} - 45415246\sqrt[3]{3} + 120355058\sqrt[3]{9} + 34313608\sqrt[5]{5} - 46871222\sqrt[5]{25} + 1889906\sqrt[5]{125} + 58073126\sqrt[5]{625} + 28814803\sqrt{2}\sqrt[3]{3} - 18280543\sqrt{2}\sqrt[3]{9} - 54164855\sqrt{2}\sqrt[5]{5} + 34244603\sqrt{2}\sqrt[5]{25} + 3148973\sqrt{2}\sqrt[5]{125} + 3601201\sqrt{2}\sqrt[5]{625} - 25350052\sqrt[3]{3}\sqrt[5]{5} + 28693784\sqrt[3]{3}\sqrt[5]{25} - 32961664\sqrt[3]{3}\sqrt[5]{125} + 18893046\sqrt[3]{3}\sqrt[5]{625} - 23831362\sqrt[3]{9}\sqrt[5]{5} + 11391866\sqrt[3]{9}\sqrt[5]{25} + 17723056\sqrt[3]{9}\sqrt[5]{125} + 1770832\sqrt[3]{9}\sqrt[5]{625} - 5550819\sqrt{2}\sqrt[3]{3}\sqrt[5]{5} - 36110637\sqrt{2}\sqrt[3]{3}\sqrt[5]{25} + 15291845\sqrt{2}\sqrt[3]{3}\sqrt[5]{125} + 12555731\sqrt{2}\sqrt[3]{3}\sqrt[5]{625} + 47502503\sqrt{2}\sqrt[3]{9}\sqrt[5]{5} + 2431211\sqrt{2}\sqrt[3]{9}\sqrt[5]{25} - 10784899\sqrt{2}\sqrt[3]{9}\sqrt[5]{125} + 18308051\sqrt{2}\sqrt[3]{9}\sqrt[5]{625}$$

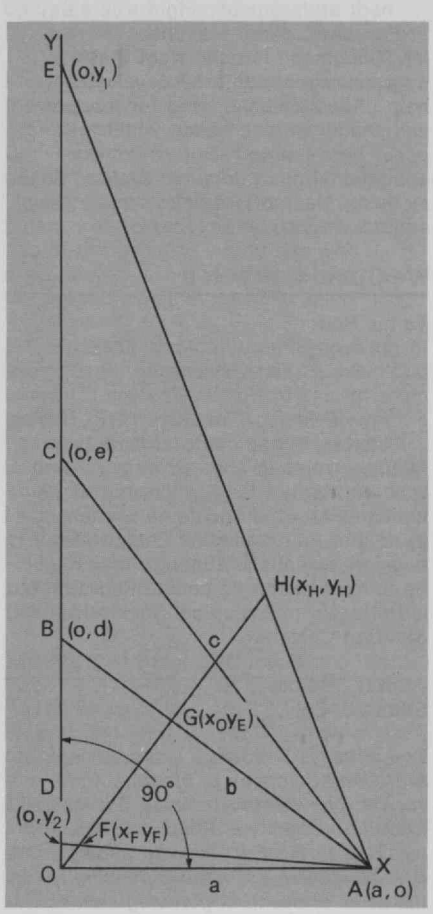
In connection with his solution, Mr. Rowe notes that an algebraic expression and its RF are complementary. Thus, if this RF had been given, its RF would have been computed the same way, with 30 unknowns, deriving that 27 were 0 and three were 1—as in the given

denominator. "As a commentary on solving 29 simultaneous equations the hard way," Mr. Rowe writes, "I note that, being retired, I had lots of time. But were I not retired, I would have programmed the job for a one-minute task on an I.B.M."

Also solved by J. Q. Longyear and Walter Penney.

20 Construct a triangle given: 1. The bisector of side c; 2. The altitude on side c; and 3. The bisector of the angle opposite side c.

The following solution was submitted by William Burgess:



Given OA = a, OB = b, and OC = c, the problem is to construct triangle APE so that EC = CD, angle DAB = angle BAE, and OA is perpendicular to DE: $b > a$ and $c > b$. Lay out a along the x axis and find points B and C.

Let $OB = d(\sqrt{b^2 - a^2})$.

Let $OC = e(\sqrt{c^2 - a^2})$.

From C strike an arc of radius $\sqrt{e^2 - a^2 + (e/d)\sqrt{a^2 - d^2}}$, striking OY at D and E. Triangle ADE is the required triangle.

To find the length of $\sqrt{e^2 - a^2 + (e/d)(a^2 - d^2)}$ consider that this term may be expressed as

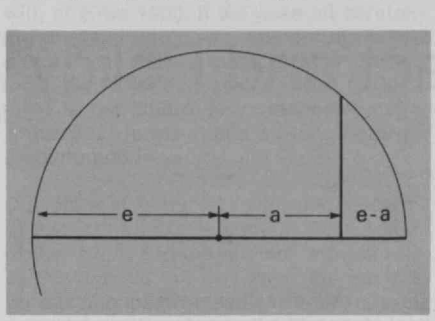
$$(\sqrt{e^2 - a^2} + \sqrt{(e/d)(a^2 - d^2}^2 - \left(\sqrt{2\sqrt{e^2 - a^2}\sqrt{(e/d)(a^2 - d^2)}}\right)^2$$

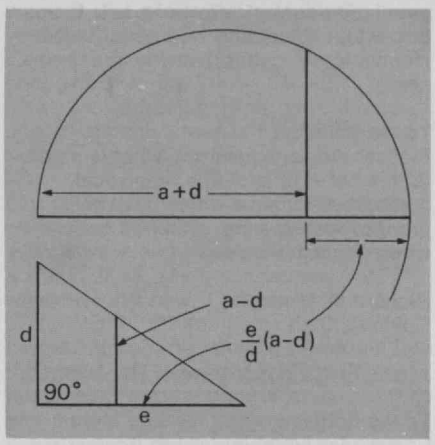
Let $\sqrt{e^2 - a^2} = 1$,

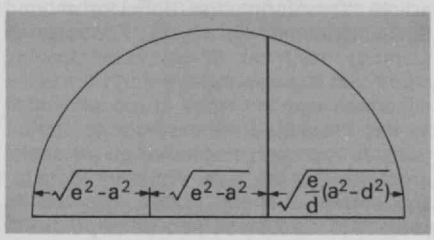
$\sqrt{(e/d)(a^2 - d^2)} = 2$,

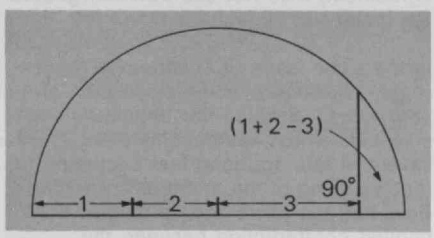
$\sqrt{2\sqrt{e^2 - a^2}\sqrt{(e/d)(a^2 - d^2)}} = 3$;

then $e^2 - a^2 + (e/d)(a^2 - d^2) = (1 + 2 + 3)(1 + 2 - 3)$.









To prove that ADE is the required triangle, consider:

1. a is the altitude on side DE, by construction.
2. c bisects side DE, by construction.
3. To prove that angle DAB = angle DAE, draw line OH perpendicular to line AB, intersecting AD at $F(x_F, y_F)$, AB at $G(x_G, y_G)$ and AE at $H(x_H, y_H)$.

Assume that FG = GH; then BA bisects angle DAE as required. We know C is the midpoint of DE; therefore $y_1 + y_2 = 2e$. We also assume $y_F + y_H = 2y_G$. We can then write equations of the lines as follows:

AD: $x/a + y/y_2 = 1$

AB: $x/a + y/d = 1$

AE: $x/a + y/y_1 = 1$

OH: $x/d = y/a$.

Solve for coordinates of points F, G, and H, finding:

$y_F = (a^2y_2)/(a^2 + y_2d)$

$y_G = a^2d/b^2$

$y_H = (a^2y_1)/(a^2 + y_1d)$

Set $2y_G = y_F + y_H$ and solve for y_1 and y_2: gather the $(y_1 + y_2)$ terms and y_1y_2 terms, remembering that $y_1 + y_2 = 2e$ and that $y_1 = 2c - y_2$. This will give a quadratic equation in y_2 which is in the form

$Ay_2^2 + By_2 + C = 0$.

Using $y_2 = (-B \pm \sqrt{B^2 - 4AC})/2A$ and simplifying, y_2 will be found as

$e \pm \sqrt{e^2 - a^2 + (e/d)(a^2 - d^2)}$;

y_2 is the negative value and y_1 is the positive. This is per construction.

Also solved by Steve Deutsch, Raymond Gaillard, R. Robinson Rowe, and John T. Rule.

Better Late Than Never

Solutions to problems published earlier have come from readers as follows:

2 Michael Rolle and J. Q. Longyear

5 Several solutions were received immediately after publication in addition to Winslow H. Hartford's, published in February. The other names were inadvertently omitted: Jerry Blum, Harold Donnelly, Thomas B. Jabine, Hubert duB. Lewis, Mrs. Martin S. Lindenberg, E. C. Signorelli, and the proposer, Smith D. Turner.

6 and **7** Charles Bures and Michael Rolle

8 The Olive Drab Phantom

11 Hugh D. Sims

12 Robert W. Baird and Paul Schweitzer

13 Mark Baldwin and John T. Rule

14 Charles Bures

15 Charles Bures, John T. Rule, Paul Schweitzer, and Steven Winkler.

Allan J. Gottlieb studied mathematics at M.I.T. with the Class of 1967, and he is now pursuing advanced study as a teaching assistant at Brandeis University. Send solutions, problems, and comments to him at the Department of Mathematics, Brandeis University, Waltham, Mass. 02154.

April Tech-Crostic Solution

Drugs for injection are necessarily in solution and solutions which are not sterile, isotonic, and neutral in pH, or nearly so, are damaging. Drugs taken by mouth may be solutions, suspensions, or solids, usually made into tablets or enclosed in capsules.

—C. R. B. Joyce, *Psychopharmacology.*

Questions of Fact and Policy

On Social Systems

To the Editor:
The immediate conclusions implied by Professor Jay Forrester's thoughtfully provocative article "Counterintuitive Behavior of Social Systems", (*see* Technology Review *for pp. 52-68*) are that world "systems" are pretty complex, perhaps even "counterintuitive," and that there's not much to be done by way of ameliorating the predicted decline in quality of life. Perhaps such pessimism is not altogether warranted: while no doubt implied, I should have preferred an explicit statement to the effect that this decline is the consequence of burgeoning population. Matrices of difference equations may improve upon seat-of-the-pants notions of system dynamics. But the ultimate stable state matches population level to pollutant burden (itself a function of resource expenditure). The problems of predicting multi-loop, nonlinear system behavior seem less formidable than those of determining, let alone attaining, optimal population levels—optimal in the sense of maximizing human values in a hostile environment.

I only raise the point because it's my ill-informed guess that one is better off attacking the population problem directly (as opposed to letting nature wend her merry way, or, for that matter, by employing secondary procedures, such as limiting capital investment). The sooner we squarely face the underlying questions of values, the better quality of life we'll bequeath our kids. But to attack these formidable, emotionally-charged issues in rational fashion, we'll need the insight and understanding afforded by just such work as is evidenced by Professor Forrester's article.

Neal Eddy
Weston, Mass.

Professor Forrester responds:
The last figure in my article included a drastic assumption of 50% reduction in birth rate, other things being equal. It seems that population control programs have not been successful and, as treated more fully in my forthcoming book *World Dynamics* (Wright-Allen Press, 238 Main Street, Cambridge, Mass.), there are basic reasons in the "counterintuitive" structure for such population-control efforts to fail. It appears that restriction on capital investment and agriculture will be required also.

To the Editor:
Please. World dynamics—what is next? Is this not a little sterile, analytical, pretentious? Love a woman, eat an orange, sing a song, watch a baby—world dynamics indeed!

Richard M. Males
Oakland, Calif.

Modeling Employment Problems

To the Editor:
I have read with very great interest the article "Counterintuitive Behavior of Social Systems" by Jay W. Forrester (*January, 1971, pp. 52-68*), and I conclude that the approach which he has described and the types of models which he has developed are essential to any rational approach to the variety of social problems that we face. While the details and structure of the models may be subject to discussion and perhaps disagreement, I do not see how the general approach can be faulted.

In the same issue of *Technology Review* (*page 79*), there is some discussion of the employment problem for engineers and scientists which has become quite severe of late and is at last beginning to receive some of the attention it should have had ten years ago. In view of the implied contradiction between the apparent needs of society and the employment opportunities now open to engineering graduates, I ask whether you know of any investigations of this problem that may have been made along the lines which you have been pursuing so successfully. It would seem that some of these questions could be isolated enough to develop a sufficiently convincing nonlinear feedback model which might provide a more effective basis for decision and could put to rest once and for all the poorly thought-out results of linear extrapolation.

T. Teichmann
San Diego, Calif.

Professor Forrester responds:
Mr. Teichmann is quite right that a dynamic model could be developed to help understand the need for manpower and the divergent trends which often occur between various parts of our educational and economic system. Such modeling has not yet been done in any serious way, so far as I know.

We Stand Corrected

To the Editor:
In reviewing Paul and Anne Ehrlich's book, *Population, Resources, Environment: Issues in Human Ecology* (Technology Review *for January, p. 16),* James J. MacKenzie has made at least two factual errors: 1) *The Population Bomb* was written by Paul Ehrlich, not as he indicates by Paul and Anne Ehrlich; and 2) neither Paul nor Anne Ehrlich are physical scientists, although they might be flattered to be so called. Paul Ehrlich is Professor of Biological Sciences at Stanford University.

John H. Thomas
Stanford, Calif.

The writer is Associate Professor of Biological Sciences at Stanford University. The reference to the Ehrlichs as joint authors of The Population Bomb *was due to the Editors, who apologize. Dr. MacKenzie accepts responsibility for the error of describing ecologists as physical rather than natural scientists, which he regards as "rather trivial." His point, he says, "was to indicate their professional competence as scientists on the issues they were treating."—Ed.*

On Combustion and Pollution

To the Editor:
I have read Bruce S. Schwartz' article (*"Automobiles vs. Clean Air,"* Technology Review *for January, pp. 20-29*), and also the chapter on "Energy, Engines, and Hobbies" in Dr. Vannevar Bush's book *Pieces of the Action* (*see* Technology Review *for April pp. 16-17*). It seems to me that the proper approach to the problem of cleaner automobile exhaust is to try for complete combustion in the engine, and not to produce avoiding the production of quantities of carbon monoxide, wasting a lot of power (80 per

cent), and running the great risk of CO poisoning.

This approach to the problem was made in the early 1900's by a very practical engineer, Edward Coverly Newcomb. He was a very close friend of my father and I met him when I was still a teenager. In the early 1900's (or possibly late 1890's) he designed, patented, manufactured, and tested a new type of carburetor containing a linkage between the float and the air inlet mechanism to obtain a correct mixture at all speeds and thus to obtain complete combustion. Tests were run with an old air-cooled Franklin (remember them?) giving up to 85 miles per gallon. I realize that this mileage was partly due to the higher Rankine efficiency of the air-cooled engine, which operates at a higher temperature than the conventional water-cooled engine.

I have tried to obtain the patent number but have been unable to do so. Mr. Newcomb told us that the Studebaker Co. was purchasing his patent and building a laboratory for him and supplying manufacturing facilities. Later the patent was taken over by (guess who) one of the gasoline producers who pigeonholed it, not wishing to experience the probable loss of gasoline sales.

I think this lead should be followed up promptly and vigorously to see if carburetor design can be greatly improved, instead of scrapping the conventional engine, causing an enormous upheaval in the automotive industry and requiring a long expensive retooling program. I hope this letter will not be pigeonholed as the Newcomb patent was.

Lawrence H. Bailey
Duxbury, Mass.

Messes of Fact and Fear

To the Editor:
Having just read Daniel S. Greenberg's article, "The New Politics of Science," in the February issue of *Technology Review,* I find myself deeply troubled—not so much by what Mr. Greenberg says, but by the underlying basis for his excellent and seemingly rational discussion of why U.S. science is and must further be more responsible to today's social needs. I find him saying that science—having created the mess we are in—has failed to get us out.

Maybe we ought to see what the mess is, when it came about and when it matured, and then see what science had to do with it and when. We have messes of fact and messes of fear.

Two of our biggest messes of fact are pollution and our cities. Pollution comes about because people like to eat, keep warm (or cool), and move about. Moreover, most of us live in cities and don't grow our own food. Therefore we can neither plow under the potato peel nor our excrement, so we pile them up and pour them into rivers, if we don't leave them lying around—which partially describes the problem of our cities.

We not only like to move about, but we like to have the products of the country in our cities, for example, so we pollute with cars and trucks as well. But eating is a pretty old practice, not even a product of science, and the automobile and oil and gas were products, if you will, of circa 1900. If we were all scratching the land again, we wouldn't have much in the way of cities or their problems. But what caused the latest movement to the cities? Farm machinery, whose first forms appeared long before the automobile.

Our big fear is nuclear war, and related to this is the missile array of Russia and of the U.S.A. But the nuclear warhead itself developed out of a very real international crisis; nuclear weapons were dropped on Hiroshima and Nagasaki in the fear of a prolonged and deadly "conventional" war with Japan. It's not sufficient now to say any of those assumptions were wrong. Those decisions were made with information on hand then, and all we can prove is what happened, not what could have happened.

Fortunately for us all, the missile standoff has worked—it's been a stand-off even if we are unhappy and nervous about it. If we want to progress from where we are now, I recommend we get at the root of the problems—the population expansion, the moving of people into the cities (but the moving of jobs out of the cities), and the lack of understanding and mutual interest between the power nations. We'd do well to invite a flow of hundreds of Russians and Chinese to come here to live for six-month or one-year periods at our expense, just to develop a common bond between us. In the meantime, using some more old technology, we could clear up the garbage and sewage better. Using some political guts and old technology we could substitute mass transportation for automobiles at least in our cities and, employing the people already stuck in the cities, we could get the slums rebuilt and the cities revitalized.

And if all this is too simplistic, so is whacking science over the head because people behave the way they do.

William G. Denhard
Cambridge, Mass.

The writer is Associate Director of the Charles S. Draper Laboratory division of M.I.T.—Ed.

Science of the New Left

To the Editor:
Daniel S. Greenberg's article entitled "The New Politics of Science" (Technology Review *for February, pp. 40-45*) gave an interesting analysis of the present political difficulties of science in Washington, but this analysis is marred by some sophomoric generalizations that need to be challenged. In fact it is incredible that the Editor let them go by unchallenged.

I object to the statement that (page 45, column 1) ". . . it would be desirable to tear apart the fiction that depicts the Defense Department as a benign, disinterested patron of science." That some empire builders in the halls of science and engineering got burned, true enough. But why deny the vision, the courage, and the generosity of many of the research programs supported over the last 25 years by the Department of Defense? Everyone knows that the Office of Naval Research was the inspiration for the National Science Foundation. For many years, DOD effectively supported the long-range national interest in scientific research. For that they deserve our gratitude. It is clear that Mr. Greenberg's political passion colors his perception.

He also says of some young scientists (page 45, column 2) that ". . . they are trying to bring the adversary process into the affairs of science and technology, and that is all [sic] to the good." So we are invited to view the "adversary process" of the Chicago thugs who interrupted the A.A.A.S. meetings last December as "all to the good"! I support rational examination of the purposes and priorities of science, but strongly oppose infringing on my fellow citizens' rights to freely assemble to discuss issues of their own choice.

Charles A. Desoer
Berkeley, Calif.

More on the Apollo Decision

To the Editor:
I think your reviewer of my book *The Decision to Go to the Moon (February, pp. 21-22)* has misread my analysis in a couple of places.

He accurately lists my "four conditions for an Apollo-like decision" but then concludes that they make it sound not "unlikely" that other Apollo-like enterprises can be begun. But I think that if these criteria, particularly numbers 2 and 3, are applied to specific policy areas they will be found quite constraining. There are few issues in American politics where the power of those favoring change is greater than those opposing it, and traumas are not that conveniently frequent. I probably should have said this explicitly in the book, rather than letting the difficulties remain implicit. Perhaps also I was more of an optimist two years ago.

My major complaint is your reviewer's misinterpretation of my "national interest" argument. I suggest that President Kennedy shared that sense of manifest destiny and national mission which made this country feel responsible in some way for the "salvation" of other peoples who do not have the benefits of a capitalist democracy. We spread our way of life, as you suggest, but so that others might share in our good fortune. This attitude—hubris or benevolence, depending on your values—was, I suggest,

at the root of America's emergence into the world in this century and of the set of post–World War II priorities which gave primacy to foreign policy.

I think my analysis, read this way, is a more convincing explanation of the roots of Kennedy's behavior, and of the behavior of the American establishment in general, than that your reviewer suggests. His gratuitous remark about the entertainment value of the analysis is, thus, I think, somewhat unnecessary.

And what does the last sentence mean?

John M. Logsdon
Washington, D.C.

The writer is Assistant Professor of Public Affairs and Political Science at the George Washington University.—Ed.

From the Senate of Canada

To the Editor:
In his article on "Science Policy in Canada" (Technology Review *for February, pp. 34-39),* Leonard Bertin did not mention the activity of the Senate of Canada Special Committee on Science Policy which has been active for the last three years. The Committee held public hearings with representatives of government and agencies, Canadian universities, private firms, provincial governments, labor and other organizations, and private individuals. The proceedings of these hearings, along with any briefs submitted, were published and added up to some 10,000 pages; these proceedings would be a useful reference for anyone interested in Canadian science policy.

Mr. Bertin mentions in his article information on SCITEC. This organization was born due to a challenge from members of the Senate Committee to representatives to various scientific and provincial associations during the group hearing.

Last December the Senate published Volume I of its final report, and I think this would be a useful supplement to Mr. Bertin's list. The Committee's report gives a historical review of the development of Canadian science policy, compares the current Canadian situation with that of other countries, and quotes the evidence presented at hearings with regard to certain problem areas.

Philip J. Popock
Ottawa, Canada

The writer is Director of Research for the Special Committee on Science Policy of the Senate of Canada.—Ed.

Mr. Bertin responds:
Mr. Popock is right in taking me to task for not mentioning the activity of the Senate in my recent article on scientific policy. The report of that Committee (of which only Part I has been published to date) was not available when the article was written. Having now seen it, I would venture the opinion that it is a disappointing document when viewed against the background of material already published. The Senate does not make scientific policy, of course. The chief value of the hearings, in this writer's opinion, has been that they were conducted in a way that attracted sustained attention in the news media. Thus, although lack of scientific and engineering expertise sometimes prevented members from pressing their inquiries to useful conclusion, they did maintain public and governmental awareness of the Canada's need for a positive science policy.

Engineer and Engineering

To the Editor:
I am proud of the fact that my degree is in engineering—and concerned for the profession in which I practice. It seems to me that M.I.T., as one of our outstanding engineering schools, should bend every effort to identify the engineer as a part of its concern and the training of engineers as one of its major roles.

I was disturbed, therefore, as I opened the February, 1971, issue and looked at the table of contents on page 3. Not once is the word "engineer" used, but "science" and "scientist" are continually referred to in connection with the articles therein.

May I suggest that an issue devoted to social and technological change certainly ought to recognize that the change and the solutions to the problems of our society today are going to be accomplished by engineers.

Paul H. Robbins
Washington, D.C.

The writer is Executive Director of the National Society of Professional Engineers.—Ed.

Saving Heat—and More

To the Editor:
Concerning the use of lower-entropy heat from power generation for heating greenhouses (*see "Saving Waste Heat," February, p. 55*), additional advantages, economic and ecological, stem from the application of waste heat to greenhouse heating. It should not be necessary to apply insecticides, pesticides, etc., in the enclosed environment. Also surplus fertilizer, rather than running off to fields and streams, could be collected in an under drain system and recycled.

David G. Prosser
Mequon, Wis.

A View of the Classroom

To the Editor:
The enthusiasm of the young student pictured on page 19 of the February issue of *Technology Review* is such an obvious contrast to the pessimism of your reviewer (George E. Hein) as to make me hope that the professor could somehow be persuaded to disqualify himself from any future teaching assignment. If he injects his defeatist philosophy into the minds of his students (who presumably plan to teach some day), what hope is there for our educational system?

His statement that "Black students learn every day that they will remain poor, oppressed and disenfranchised" is completely uncalled for in this review and is such a deliberate distortion of the facts as to make me suggest to you that this reviewer should sell his services to the University of Moscow rather than to the *Review.*

Your statement that the reviewer intends to "warn against neglect of the awkward practicalities of the classroom" is very charitable indeed. Far better that he forget the pessimism (or the realities as he sees them) and spread some enthusiasm for the job to be done, as did my M.I.T. professors for me.

Charles E. McCulloch
Westfield, N.J.

"The Old Bull Uncornered"

To the Editor:
Until recently, *Technology Review* has been scholarly and dignified. But with publication of "The Old Bull Uncornered" (*March, pp. 70-71*) you are reaching the nadir of biased and unobjective comment. The gloating over the performance of the hippies at the A.A.A.S. meeting in Chicago indicates the mentality of your writer, who has not the courage to sign his name to the article. Even the liberal *New York Times* in its editorial called the heckling and placard raising at that meeting disgraceful.

The height of bad taste was reached in the reference to "pant leg lifted revealing the brace on his right leg." Even the Roosevelt-haters were considerate in not speaking of his handicap.

I am wondering if the "Teller haters" really believe that we would have been better off if he had not worked on the hydrogen bomb and allowed Russia to develop it unilaterally. Please do not tell me that peace-loving Russians of the MIRV's and SS9's would have put away their drawing boards and closed their arms factories in that event.

John S. O'Conor, S.J.
Philadelphia, Pa.

The writer is chairman of the Physics Department at Saint Joseph's College, Philadelphia. That "The Old Bull Uncornered" appeared without attribution was a technical oversight in our editorial offices; it was written, following her observations at the Chicago meeting of the American Association for the Advancement of Science, by Deborah Shapley, Associate Editor of the Review. *—Ed.*

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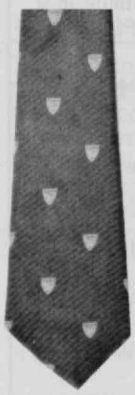

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TR-71

Institute Review

Recent Graduates: A New Class of Corporation Membership

Younger alumni of M.I.T., including members of the Class of 1971, will soon have representatives on the M.I.T. Corporation, the Institute's "board of trustees."

Members of the Corporation approved on March 5 the creation of a special category of membership, Representatives from Recent Classes, and the election of five alumni to five-year terms effective in June. Procedures for selection of the five new Corporation members are now under way.

In announcing the new plan for extending membership on the Corporation, President Howard W. Johnson noted that the group has been "active in broadening its membership for the past several years. I am very pleased at this decision," President Johnson said, "which reflects the desire of the Corporation to place greater emphasis on the perspective of recent student experience."

There has been a recent effort to include younger members on the Corporation, and the first woman—Mary Frances Wragley, '47, Headmistress of St. Paul's School for Girls in Baltimore—was elected in June, 1970. But the basis on which most Corporation members are chosen, including those nominated by the Alumni Association, tends to give preference to older candidates who are known to their colleagues either personally or by reputation. Hence the Corporation's decision on March 5 to provide a special category and thus assure the election of a number of very recent graduates. *The Tech* gave principal credit for the plan to James R. Killian, Jr., '26, Chairman of the Corporation.

The Corporation's plan provides that one alumnus will be nominated for Corporation membership each year from among their number by the members of the senior undergraduate class, graduate students completing their terminal year of study, and all those who received undergraduate or graduate degrees from the Institute during each of the two calendar years immediately preceding the year of the election. Suggestions will be solicited from this group in advance of the voting for nominees, and from these suggestions a ballot will be assembled by a Screening Committee composed of incumbents in the "Recent Classes" category of the Corporation. Final election will be by members of the Corporation each June.

This year, in order that the new category of Corporation membership can be filled immediately, the eligible classes will select five nominees for terms ranging from one to five years; beginning in 1972 one nominee, to fill the single expiring term, will be chosen annually. Alumni who received degrees since January 1, 1969, or who expect to receive degrees before December 31, 1971, are now participating in this year's nomination.

Joining the Alumni Council, perhaps for the last time as President of the Institute, retiring President Howard Johnson spoke to alumni of the future of M.I.T. In a question and answer period following his address, the last alumnus to be recognized from the floor had this to say: "Many ask why we did so well during the recent disturbances on campus and one name always comes up—and that name is yours, sir."

On Facing the Future

No quiet harbor, M.I.T. has traditionally manned the battlements at the frontiers of problem areas, President Howard W. Johnson reminded alumni who gathered at a midwinter meeting of the Alumni Advisory Council at the M.I.T. Faculty Club. Speaking of the disquiet of the past few years—last year in particular—and looking toward the next few years as a period of trial for the whole of higher education, President Johnson asked: "How could we have stayed aloof? Both as an urban and scientific/technological institution, M.I.T. is of necessity caught up in the rigorous questioning of the values such an institution as ours represents." He made it clear that to remain first rate there could be no retreat.

To assess how well M.I.T. or any other institution of higher education will do in these difficult times, President Johnson posed three questions; their answers are

decisive: First, has M.I.T. remained a place where effective education takes place, providing a first-rate environment for the education of the young? Second, can the Institute govern itself? And third, can M.I.T. finance itself?

"Yes," said Mr. Johnson in answer to his first question. "M.I.T. has remained first-rate though it can and must improve. M.I.T.'s standards are perhaps tougher than ever and are getting more high quality performance from more students than ever. I really feel we're on the right track. Despite trials and changes, the state of education at M.I.T.—and hence its service to society—is a positive one."

Speaking on governance, President Johnson pointed out that in the broadest sense this means seeing to it that the corporation, the faculty, the administration, the students, the staff, and the alumni are all working together. Then, governance in the narrow sense poses the problem of whether or not the Institute can protect itself. "Many have criticized the ways in which that can take place," President Johnson said, "but we must remain open as a rational place, a forum of differing ideas—not as an adversary in the political arena. I think M.I.T. has met the challenge of defense successfully. We've done all right til now, and I think signs for the future are better."

It was the question of M.I.T.'s continuing ability to finance itself that seemed to gather the most storm clouds on the Institute's horizon. In better shape than many of its competitors—cash reserves are currently available to cover the current operating deficit—M.I.T. is none the less facing a funding crisis. "Looking forward two to four years there is only gloom ahead. That's why we make such great efforts at cost-cutting and holding our expenses down now. But the real disease is not the internal budget, but the dependence on 'soft money' to support projects for a few years. When it starts to fall away, these projects must be supported by 'hard' after tax money. The superstructure of the Institute has depended heavily on soft money in the past. With a few breaks and your help, we'll come through," Mr. Johnson told the alumni.

"There are no snug harbors. If we stop going out into the rough seas we will no longer be M.I.T. Education is centered around the solution to great scientific and technological questions of modern life; technological problems that we helped to create. So we must face these challenges seeking technological solutions with good human result. How right that M.I.T. should be in that forefront," President Johnson concluded.

Whitney M. Young, Jr., 1921-1971

Whitney M. Young, Jr., a distinguished U.S. civil rights leader who had been a member of the M.I.T. Corporation since October, 1970, died suddenly in Lagos, Nigeria, on March 11. He was Director of the Urban League, a member of the President's Commission on Law Enforcement and Administration of Justice and of the President's Committee on Youth Employment, and President of the National Association of Social Workers.

Prior to his election to the Corporation, Mr. Young had been a member of the Visiting Committee for the Harvard-M.I.T. Joint Center for Urban Studies from 1966 to 1970, and he studied electrical engineering at M.I.T. as a member of the U.S. Army in 1942-43. President Howard W. Johnson said, "The country has suffered a deep loss in the death of Whitney Young. We at M.I.T. will greatly miss his wise counsel as a member of the Corporation."

Mr. Young was in Lagos for a Ford-Foundation-sponsored meeting of Americans with African leaders.

Ending the "Princeton Plan"

The one-year experiment with a week's vacation in October at the midpoint in the fall term—the so-called Princeton Plan to give students an opportunity to participate in political campaigning prior to fall elections—will not be repeated in 1971.

The Committee on Educational Policy told the faculty in March that it could not make a full evaluation of the 1970 vacation experiment; but most faculty members seemed to judge that few students had taken advantage of the arrangement for its intended purpose—that of "legitimate" political action in support of candidates in the November elections. There being no elections in 1971, the faculty voted to return to the regular fall-term schedule for 1971-72. The result provides for registration on September 13; vacations on Columbus Day (October 11), for Veterans' Day (October 25 and 26), and for Thanksgiving (November 25 and 26); and final examinations on December 16 and 17, leaving the month of January, before the opening of the Spring Term, for an Independent Activities Period.

Killians Remembered

A family party tendered by wives of M.I.T. faculty brought more than 300 guests to the Museum of Science late in March to honor Dr. and Mrs. James R. Killian, Jr., '26, upon his retirement this June 30 as Chairman of the M.I.T. Corporation. It was the first in a series of Cambridge events in tribute to the Killians which will culminate at the 1971 Alumni Homecoming Day on June 7.

The evening was devoted to a report by George R. Harrison, Dean Emeritus of the School of Science, of his conversation with a computer—identity not revealed—about its stored memories of milestones and other events in the 48 years since one sophomore—Killian—was added to the M.I.T. Class of 1926 by transfer from what is now Duke University. The computer assured him, said Dean Harrison, that the report had "at least an air of verisimilitude" to the history of James Rhyne and Elizabeth Parks Killian in the M.I.T. community.

Dean Harrison's account was interrupted early in the evening by Harold E. Edgerton, Sc.D.'31, and Truman S. Gray, Sc.D.'30, both of the Department of Electrical Engineering, who unveiled "Killian's Song," to be sung to the title melody of Gilbert and Sullivan's *Pinafore:*

"When I was a lad I began to shine
At a college down below the Mason-Dixon Line;
But I felt that I would never get ahead
'Til I met a clever girl that I might wed.

"To Jim and Liz, with admiration, gratitude, and love," toasted Mrs. Karl T. Compton, whose husband was the Institute's ninth President, at a faculty dinner honoring Dr. and Mrs. James R. Killian, Jr. ('26), this spring. With her at the head table were President Howard W. Johnson; Jerome C. Hunsaker, '12, Emeritus Professor of Aeronautical Engineering; and Robert B. Newman, M.Arch.'49, Associate Professor Architecture, whose wife was chairman of the event. Earlier, Dr. and Mrs. Killian had received faculty guests—including (below) Dean and Mrs. Paul E. Gray ('54), Chancellor-Elect.

So I came up North to finish my degree,
And I soon became the President of M.I.T."

Several stanzas later, referring to Dr. Killian's 13 years with *Technology Review* (nine as Editor):
"I flourished that pen with such manifest joy
That K. T. appointed me his office boy.
Then he went off to war with a smile so bland
And it soon became apparent I was in command.
I juggled the budget so expertly
That I soon became Vice President of M.I.T."

At dinner preceding the evening's entertainment Mrs. Karl T. Compton offered the Killians a toast, recalling their "long dedication" to M.I.T., the "gallant spirit, courage, humor, and tenacity . . . [that have been] an inspiration to us all."
And as the evening ended, Dr. Killian responded by referring to his and Mrs. Killian's "sense of affection, gratitude, and emotion. It is a rare privilege to be members of this community," he said.

The Ashdown Fund

To honor a long-time member and officer of the Northeastern Section of the American Chemical Society, its members have established the Avery Allen Ashdown Fund in memory of the late Professor Ashdown (Ph.D.'24), who died on July 15, 1970, after nearly 50 years' service on the staff and faculty of the M.I.T. Department of Chemistry (*see* Technology Review *for October/November, 1970, p. 101*).

"Throughout his life," says the Section's announcement of the tribute to Professor Ashdown, "he was a dedicated teacher and chemist, and in both capacities his outstanding quality was one of selflessness." Though the appropriate memorial has not yet been selected, the Section insists that "it must recognize Professor Ashdown's sympathetic service to students," says Arnet L. Powell, Chairman of the Section's Ashdown Memorial Committee.

Professor Ashdown was a Past Chairman of the Section and served for many years as a Trustee and as Editor of its periodical, *The Nucleus*. Contributions to the Fund may be sent in care of the Northeastern Section, American Chemical Society, Chemistry Department, Tufts University, Medford, Mass. 02155.

The Race for Clean Air

The official documentary film of the 1970 Clean Air Car Race (*see* Technology Review *for January, pp. 20-29*) has been completed and now is available for distribution from its producer, Tech Films Corporation, according to William J. McCrea, '61, President of the company.

The 26-minute 16-mm. color movie, "The Race for Clean Air," has been produced by Thomas Minchin from over 60,000 feet of film made before, during, and after the race in the summer of 1970; it includes a brief analysis of the dynamics of forming pollutants in internal combustion engines as well as the report of the race and of the various entrants' plans for controlling their vehicles' effluents. Original music was provided, and narration is by Alexander Scourey.

The film is available for rental ($37.50 for a single showing) or purchase ($375) from Mr. McCrea's organization at 222 Arsenal Street, Watertown, Mass. 02172.

A Human Face for Technology

"Technology will have a human face when a car can be a friend to a tree," suggested Walter A. Rosenblith, M.I.T. Associate Provost, at the Alumni Regional Conference in Gaithersburg, Md.—site of the National Bureau of Standards campus—on February 27, 1971. The conference, hosted by Lewis M. Branscomb, N.B.S. Director, and under the chairmanship of Sterling H. Ivison, Jr., '41, sought to explore the present and future responsibility toward society of scientists, and those responsible for the education of young people now preparing to enter the science professions, for the results of their labor.

President Howard W. Johnson and four senior faculty members—Robert W. Mann, '50, Germeshausen Professor of Mechanical Engineering; William H. Matthews, Ph.D.'70, Assistant Professor of Civil Engineering; Philip Morrison, Professor of Physics; and Walter A. Rosenblith, Professor of Communications and Biophysics—each added a dimension to M.I.T.'s past accomplishments and current commitment to the social applications of technology as pursued within the Institute's educational policies and in the campus' classrooms and laboratories.

Predicting a vital future for M.I.T. *(see page 85)* President Johnson especially addressed himself to those who ask: Why more choice for students? Were not the original departmental programs constructed soundly? "They were," he affirmed, reminding his audience that changes in education are inevitable particularly for an institution like M.I.T. because "technology doesn't stand still." Ever dissatisfied with the breadth of education at M.I.T., President Johnson said that nevertheless "there is a greater likelihood now that our students can develop in addition [to a sound technical education] a sense of obligation. We want to be able to visualize for our students how to put it all together so the application of technology to mankind is not separate from technology itself."

Professor Mann applies this belief to the classroom; he encourages participation of graduate and undergraduate students in M.I.T.'s Engineering Projects Laboratory. The Laboratory offers students the opportunity to participate in problem-oriented education by solving "real world" problems through design and research projects like the Boston Arm *(see* Technology Review *for December, 1968, p. 82),* ultrasonic guidance devices and a high speed Braille embosser for the unsighted—all applications of technology for the aid of the handicapped.

On the Theory of Value

But the service of science to society is no less relevant when focusing on problems of less immediate human concern. Professor Philip Morrison told the gathering that he regarded "the

M.I.T. alumni and guests gathered at the National Bureau of Standards in Gaithersburg, Md., this winter for a Regional Conference sponsored jointly by the M.I.T. Clubs of Washington, Baltimore, and Philadelphia. They heard much of the newly emerging role of science and technology in education and man-oriented pursuits. Exploring the place of conscience in applied science were: Robert W. Mann, '50 (upper left), Germeshausen Professor of Mechanical Engineering; Walter A. Rosenblith (upper center), Associate Provost; Philip Morrison (upper right), Professor of Physics; Howard W. Johnson (lower left), M.I.T. President; Lewis M. Branscomb (lower center), N.B.S. Director; and William H. Matthews, Ph.D.'70, Assistant Professor of Civil Engineering (lower right).

construction of theory—the intellectual structure by which we perceive and understand the world in which all men and their fate are immersed—as one of the truest contributions that properly directed science (and its technological counterpart) can make."

"I would hope that we will never come to the time when we do not value the importance of constructing theory. Because unless we continue to enlarge the understanding we have of the world, I don't think we'll have the courage to maintain the designs, the engineering choices, and the difficult compromises which those who cope with more mundane questions must necessarily make." With this case for the relevance of the astronomer's work to the world of man, Professor Morrison went on to show, through the recently postulated theory of "spinars"—large rapidly spinning balls of gas with a magnetic field, spinars are believed to weigh about as much as a galaxy—that the construction of theory (science before it has become tested) is by analogy exactly in the stage of the conceptual design of the engineer. "We hope it will work," Professor Morrison said, "If it doesn't we will have to go back to our drawing boards."

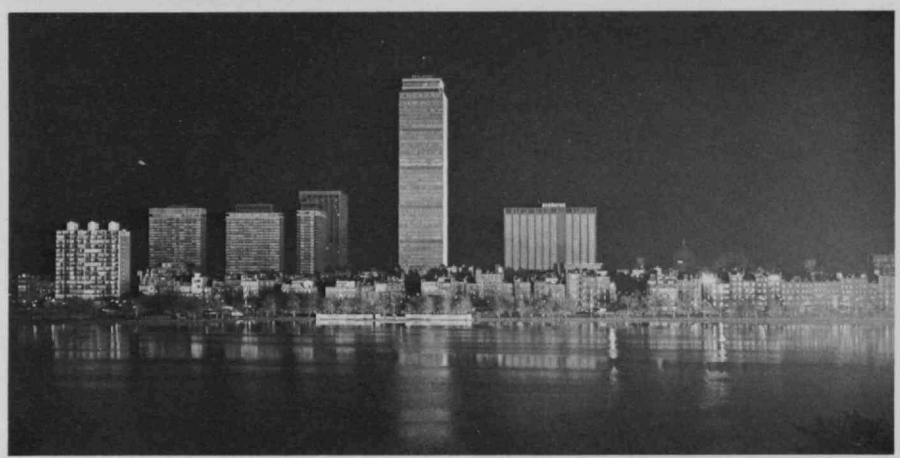
Pollution and concern for ecology—a more earthy pursuit—gave Professor Matthews an opportunity to bring alumni up to date on the state of man's knowledge of what is actually happening to the planet. He particularly recommended the S.C.E.P. report *Man's Impact on the Global Environment (see* Technology Review *for October/November, 1970, p. 58-59)* the conclusions and recommendations of an interdisciplinary study of environmental questions held last summer in Williamstown, Mass., under the direction of Carroll L. Wilson, '32, Professor of Management. The gist of the report: There is a serious lack of baseline data. It's nearly impossible to tell where you are going if you don't know where you are coming from.

Further exploring the extent to which M.I.T. education is making technology a socially responsible undertaking *(see p. 61)* Professor Rosenblith described the changing patterns of curricula and research on the campus.

Of the $60 million in research grants awarded to M.I.T.'s 20 interdisciplinary laboratories this year, roughly one-third is alloted to biomedical sciences and technology; roughly 10 per cent is in the area of urban affairs, and adding the somewhat overlapping area of environmental research this figure goes up to 15 per cent. Almost 30 per cent of M.I.T.'s research grant money is spent in these fields.

"We are discovering that if we wish to make technology and science not only a unique intellectual activity of man but also a socially responsible activity of man in a period in which technology and science have much power, then technology and science must organize themselves in a way responsive to the needs of the society," Professor Rosenblith said.

The Boston skyline, nearly a mile from M.I.T., photographed by high-energy electronic flash from the roof of the Institute's main buildings—a project of three students in the Stroboscopic Light Laboratory this winter (see story, below). Technical details: 3,000 μf. capacitance for each of two FT-17 flash tubes, triggered by a microflash unit attached to the camera 650 feet away. Later the same students reversed the process, carrying their lights to the top of the Prudential Building (below) for a night view of M.I.T.



High-Energy Photography

The assignment was to use a high-energy electronic flash for photographing distant scenes at night. High-energy? 44,000 watt-seconds. Distant? 4,800 feet. The picture at the right proves the success of three M.I.T. undergraduates—Charles E. Kushner, '72, James W. Sholer, '71, and Randall B. Sluder, '71—students in the Department of Electrical Engineering's Stroboscopic Light Laboratory under the direction of Harold E. Edgerton, Sc.D.'31, Institute Professor Emeritus.

The students made their picture from the roof of Building 2, just west of the Great Court overlooking Memorial Drive. Their flash tubes were 650 feet away on Building 1, east of the Great Court. The separation was necessary to prevent fogging from backscatter by dust particles between lamps and subject. At 1/100 sec. (f 2.8), there was no ballooning of night-time light sources, and—as the students write in their report of the project—"the resulting photographs have a quality which cannot be duplicated by daylight photographs or time exposures taken at night."

James M. Barker, '07
Honorary Director and Former Chairman of the Allstate Insurance Co.; Life Member of the M.I.T. Corporation

Modern higher education can best be improved, not by throwing out the existing plan but by recognizing the fundamental fact that the aim of higher education ought to be to teach the student how to use his mind

The Essence of Education

News reports have recently recorded the plans of one engineering school to make broad changes not only in the curriculum, but in the method of education. I am somewhat overcome by the picture of what is about to take place, for it looks to me like throwing the baby out with the bath water and then trying to conceive a new infant. Another recent newspaper article has reinforced my intention of setting down on paper some of my own conclusions about education in general, and higher education in particular. This was on the front page of the *New York Times* of November 9, 1970, where William K. Stevens wrote under a headline "Freer Choice of Studies Gaining in U.S. Colleges:"
"A movement to transform undergraduate education is making headway in colleges and universities across the country. The movement is diffuse, but energetic. Its target is the traditional but widely criticized system of teaching familiar to generations of American undergraduates.

"In the traditional system, many of a student's courses are required, and what he studies in any given course is prescribed by the professor. The professor's main job is to transmit information. He is mostly a lecturer and the student is mostly a notetaker."

The process of higher education ought to result in two accomplishments. First and most important, the student should be taught how to use whatever mind he has, or—in other words—how to think. Second, he ought to acquire a stock of facts. It seems to me that, unfortunately, in the present system of undergraduate education the process of transmitting information has been allowed almost completely to obscure the necessity of training young and impressionable minds to think.

Higher education divides rather definitely into three categories—professional, scientific and technical, and liberal arts. Professional education is generally postgraduate; those who are being educated professionally to practice in such fields as law, medicine, or business are supposed to have acquired the essentials of higher education in their undergraduate years. The aim of such professional education is indeed the transmission of facts, pertinent and fundamental to a chosen career. But, undergraduate scientific and technical education which confines itself to the transmission of information in chosen fields is essentially degrading itself to the level of trade school training. The professors engaged in it ought to be using the transmission of scientific and technical information primarily for the mental disciplining and training in thinking involved, and not merely as a means of communicating useful facts to young minds. Teaching in the liberal arts field lends itself to the simple transmission of information because the subjects being taught do not generally require close, hard thinking and mental discipline. A reasonably good memory is about all that is required to pass the tests, and I do not wonder that many students are bored with the particular information transmitted by the professor, and demand a change. In contrast, engineering and technical students have their minds disciplined to some extent by the nature of the subjects involved, and this may be one reason why minds trained in engineering have so often used disciplined intelligence effectively in broader fields, beyond the limitations of the technical profession.

The Essence of Higher Education
I continue to think that the most important thing in the educational process is that the student should be taught to use his mind. A carefully planned and executed curriculum of engineering and/or scientific subjects combined with a well-proportioned assortment of humanistic studies is one way to accomplish that end. Probably I was influenced in 1906-07 more by George F. Swain, '77 in his fourth-year course in the theory of structures than by anything else that happened to me in my four undergraduate years at M.I.T.

Professor Swain was the only teacher I ever had who said (in essence) to his classes, "You are here to learn how to use your minds. I am not simply teaching you the rudiments of how to design bridges. I am trying to show you that if you will learn how to use your minds on my subject, you will be getting mental discipline which you can apply to any problem, engineering or human." In addition to this emphasis he was

constantly invigorating his teaching by introducing his students to a wide variety of other matters, such as formal logic and history—to mention two of them. He influenced a generation of civil engineers, and also naval constructors in Course XIII-A, to think effectively, and the intelligent ones absorbed his approach avidly even though stupid individuals hated him. Some years ago Clarence D. Howe, '07, Edward L. Ryerson, '09, and I happened to meet in Chicago, and we took the occasion to compare our educational experiences. We were in complete agreement that Professor Swain did more for us than all the rest of our courses put together.

I bring up the case of Professor Swain's teaching because it illustrates what I feel is the essence of true higher education. I have said many times in later years that if somewhere, somehow, in the course of an undergraduate's four years he could be brought under the influence of *one* great teacher like Professor Swain who would inspire him to learn to use his mind, that student would have the makings of an educated man.

I bring this up in connection with the new plans which I cited in my first paragraph because I doubt whether the "innovator," as he calls himself by implication, has grasped this essential of true education which Swain so strikingly exemplified in his teaching. It seems to me that if all the members of the faculty of an educational institution could be imbued with the idea that the job of each was to use his subject to show each student how to use his mind, it would have a great effect on the quality of the institution's graduated product. A professor would start by saying to his class, "I am going to try to teach you how to use your minds effectively. My subject is a means to that end." If the subject is a scientific, engineering, or mathematical one, the professor would point out that the content in itself might be useful as such in a later professional career. In the case of humanistic subjects, the content would be useful in broadening the student's general approach to life, and his interest in what goes on in the world. The two categories of subjects would constantly illuminate the fundamental truth that scientific, engineering, and mathematical principles can be applied logically to the solution of problems in those fields, but that the successful application of humanistic principles depends not on logic but on an understanding of human emotional characteristics. Faculty members should teach themselves or be taught how to get this across to the students. Each one should tell his students in so many words that this is what he is trying to do.

As a corollary to this, I might add that what contributed more to whatever measure of success I may have had in this life has been the habit of trying to seek out the principle or principles which underlay what I was trying to do. Professor Swain showed that method by example, though he never identified it in explicit statements. I absorbed the idea, and when I had left engineering and had embarked on a banking career, one of the senior officers with whom I was working told me explicitly that he always tried to get at the principle back of everything that he was doing. Probably the thing that brought him and me together closely was that he recognized that I worked the same way.

I have practiced the principle for years. I believe this enabled me to master the banking business after two years of evening and spare-time study effectively enough to merit appointment as joint manager of a prospective foreign branch within a month after I joined the bank. When I later was invited to join a great retailing organization, never having had any experience in either merchandising or retailing, the same method enabled me to contribute to the solutions of the company's problems in those fields to such an extent that I was shortly put in administrative charge of the retail stores country-wide. Many of the principles that I identified, developed, and established are still considered fundamental in the company. I regret being thus autobiographical, and do so only to illustrate my point.

A Leaven in the Loaf

The principle of evolution holds in education as it does in all the affairs of this world. The underlying forces interact, the stronger ones tend to dominate at least for a time, and the result is constant change, as it always has been. But the principle which should govern the process of higher education must always be kept in mind. It is that higher education should consist primarily in training those minds to think that have the capacity to do it, and incidentally using scientific, engineering, and humanistic subjects not for their informational value but as material to be used in the process of mental training.

There will be a host of minds incapable of being trained to think. For them higher education will be merely a glorified sort of trade school. It has often been remarked that the total value from the informational viewpoint of a college education is small. The graduate begins to acquire command of a useful stock of specialized information as soon as he takes a job in his chosen line of work. What really counts then is whether he has learned to use his mind in thinking. If he has been taught to try to see the principles back of what he is called upon to do he will be able to appraise details as to their relative importance instead of letting the multitude of them overpower his ability to identify and make use of the important ones.

I feel strongly that it is of secondary importance what subjects the undergraduate studies in his courses, provided that somewhere among the faculty members who are teaching him there is a leaven of those who are training him how to think, and that the courses to which he is subjected include both logical subjects such as engineering, science, and mathematics, and illogical—or perhaps better said, nonlogical—subjects such as the humanities. I emphasize that it is not sufficient for the faculty to present their subjects in such a way as merely to arouse the student's interest. It is vitally important for him to realize that he is being taught to use his mind in the thinking process.

I realize that this note comes from one who is not directly involved in undergraduate teaching. However, I was a professor in the distant past, and, more than that, I have always considered that the most important aspect of my job as a business executive was to teach the people reporting to me how better to do their work, and that showing them either directly or by implication what the principles were on which their executive decisions ought to rest was the best way of getting results. I think it is safe to say that it has been successful. It encourages me to write this memorandum outlining what seems to me the direction in which the process of higher education might well move in the coming years. I am fully aware of the fact that many faculty minds are not, and probably cannot be, attuned to this approach. My thinking on that point is that if some of them can be brought to grasp the idea, it will be a leaven in the loaf of higher education which will cause the level of accomplishment of the whole to rise.

This brief note has been developed for publication in Technology Review *from a memorandum on some aspects of the present system of higher education written by Mr. Barker to James R. Killian, Jr., '26, Chairman of the M.I.T. Corporation, in November, 1970.*

Project Runnymede
Steven C. Carhart, '70

How one M.I.T. student—an organizer of the Moratorium in the fall and the Movement for a New Congress last spring—discovered that there are "so many people in positions of responsibility out there who agree with many of the ideas my contemporaries and I have had about the nature of the country's problems and possible courses of action"

Hobnobbing with the Establishment

"Why are you here?" I asked a fellow latecomer as we trudged up the snow-covered hill to Endicott House to the Project Runnymede conference on the war and foreign policy one evening late in January. He said he didn't know, and I responded that I didn't either. I still don't, but the reason may become apparent in the coming months.

Project Runnymede was an ambitious offshoot of the activities of the M.I.T. Moratorium Committee during the Cambodian invasion "strike" last spring (*see* Technology Review *for May, pp. 82-83).* One conviction which we all shared was that antiwar people on campus had been talking to themselves for too long, and that it was essential to reach out for off-campus allies. A subcommittee formed itself to visit local businessmen, explain what was going on on the campus, and explore possibilities for joint action. The group hit pay dirt when they visited Franklin Lindsay, President of Itek Corp. Lindsay offered to help set up a student-business conference to discuss foreign and military policy and what should be done about it, particularly in reference to the Indochina war.

Nine months later an impressive array of about 50 business and student leaders had been assembled at Endicott House. It was, coincidentally, the eve of the Laotian invasion, and the papers were reporting the embargo on the embargo on news of our latest military adventure.

Among the businessmen and academic leaders on hand were the Presidents of American Standard, American Smelting & Refining, M.I.T., and Bennington College; the Editors-in-Chief of the *Atlantic, Newsweek,* and the *Boston Globe,* D.O.D. troubleshooter Cyrus Vance, M.I.T. Provost Jerome Wiesner, Harvard Trustee Hugh Calkins, and former Senator Albert Gore, to mention only a few.

But why another round of palaver? What was going to come of it? Was the "ruling class," or at least part of it, ready to join students in a massive assault on our war policy? If so, why talk, why not plan? If not, was another round of talk going to accomplish anything? My more cynical friends whose antiwar efforts dated back to the McCarthy campaign or even to the summer of 1965 asked me these questions, and I had no answers.

Trust—There Is the Issue

One advantage of hobnobbing with the Establishment, though, is that you get the advantage of off-the-record, straight poop on why (or what it wants you to think is why) the administration is *really* doing what it is doing from The Man himself—Henry Kissinger, who spoke to us and fielded questions on Friday evening as the conference opened. No logically absurd, historically inaccurate Pattonesque political posturing à la presidential news conferences. Instead, *realpolitik,* albeit off the record. Throughout the evening, the theme was clear: Trust Nixon, and the war *will* end. After more Asian casualties, of course; but these must be weighed against the other consequences.

But trust—there is the issue. No amount of rational discussion can change your feelings about whether or not you trust someone and have confidence in him. For the students, of course, the issue had long since been settled; how could one *trust* Nixon, Nixon who wanted to use nuclear weapons to bail out the French in 1954, Nixon who is substituting firepower for manpower and yellow corpses for white ones, Nixon who talks about not restricting South Vietnamese options in invading North Vietnam when everyone knows the South Vietnamese army can't move two feet without American helicopters, Nixon who tried to make youth the scapegoat for the nation's problems in the last election . . .

The list goes on and on, but students won't trust Nixon even if he's doing *exactly* what they want him to do because they know he will turn on them the moment it becomes politically expedient.

The questions people asked Kissinger were meant to be tough, of course—but he had heard most of them before. One questioner, though, took a line that our powerful guest probably hadn't heard at any of his recent news conferences. Mark Gerzon, who graduated from Harvard last year, prefaced his question by recalling similar meetings he had had with Robert McNamara and McGeorge Bundy in which he had felt overwhelmed by their detailed knowledge of American policies; he found that in order to understand the why of what was going on he had to ask more personal questions. "I finally understand that there's one thing you all don't know more about, and that's the feeling of moral revulsion of young people like me about the war," he said. "So, Mr. Kissinger, I guess all I want to know is what your constellation about these things [values and ideals] when you were my age? How were you as a young man? How much have you changed since?"

There was no answer to that question, the one answer which might have told us more about what was going on in the country than any discussion of troops or aerial bombardment.

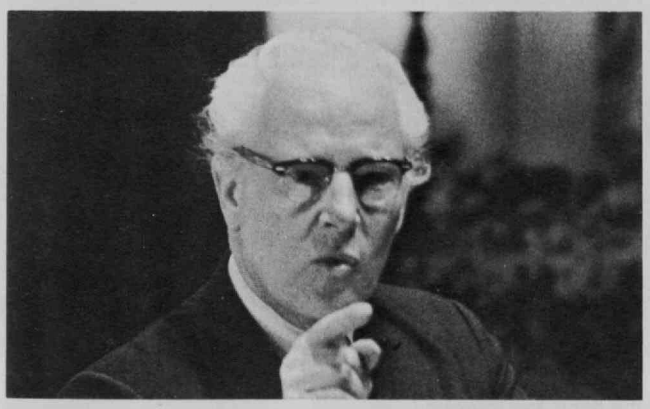
More questions followed about the cost of the war in Asian lives, and I asked about a report in the *New Yorker* that the U.S. was planning mass deportations of peasants from the northern provinces of South Vietnam, effectively turning a major portion of the country into a free fire zone.

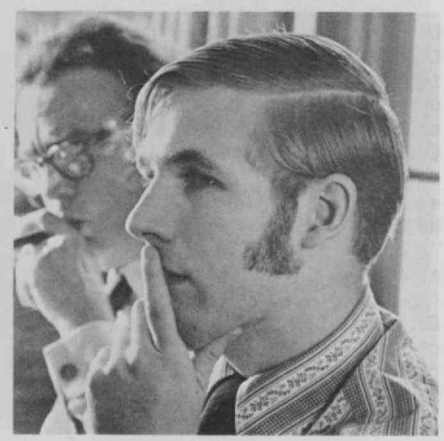
Institutional Rigidity

On Saturday, after Dr. Kissinger had left us to ponder our responsibilities and alternatives, we divided into groups to discuss whatever seemed most important to each group. While the range of topics under discussion was broad, most centered around the twin themes of Indochina and mobilization to deal with pressing domestic problems, particularly regarding the role of business in the latter effort. After exhaustive composition-by-committee and plenary nit-picking reminiscent of some S.D.S. meetings I've seen, the conference produced a statement which represented a consensus of those present and is well worth quoting in part:

"There is a compelling moral problem which the American public is not yet facing. We cannot condone a policy which merely withdraws ground troops while we are continuing to wage a war by other means which are less visible to the American public but nonetheless devastating to the people who are being bombed and whose countries are being

"One advantage of hobnobbing with the establishment . . . is that you get the advantage of off-the-record, straight poop," writes Steven C. Carhart, '70, about the Runnymede conference at Endicott House late last winter. The "establishment" included Henry A. Kissinger, Assistant to the President for National Security Affairs (top) and Senator Albert Gore (center, left). M.I.T.'s delegation included President Howard W. Johnson (center, right), Provost Jerome B. Wiesner (bottom, left), and Mr. Carhart, whose account accompanies these photographs. (Photos: Itek Corp.)





destroyed. The U.S. does not have the right to use firepower to determine who shall govern in Vietnam, Cambodia, or Laos. We see no justification for using aerial bombardment throughout Indochina, sacrificing Asian lives to save our prestige while shielding our sensibilities from the moral consequences of our war policy.

"The problem posed by the Indochina war is only one of the many issues which came before the conference. We do not have an agreed position on all of the issues we discussed. We are agreed, however, that most of the other critical issues which face us as a nation today are, like the war in Indochina, symptoms of a common set of causes: namely, a rigidity in our institutional mechanisms of change; a failure by our educational institutions and our communications media to prepare the people to participate effectively in our national processes of decision; individual and corporate failure to face up to grave violations of our national ideals and purposes; and a national reluctance to assess the true social costs of many of our political and economic programs."

The conference also produced statements dealing with the need for individuals to assume increased responsibility for the social consequences of the actions of institutions to which they belong which transcend their responsibility to the interests of the institution; the principle that the United States should not intervene abroad in conflicts which are primarily civil or revolutionary in nature; the need for a strong internationalist foreign policy with increased economic—rather than military—aid to underdeveloped nations; the need to redress the balance between the military and its suppliers and private consumption on the one hand and public services and needs on the other; and the restructuring of American institutions so that they are conscious of and take responsibility for the full social consequences of their actions.

Unanimity of Ideas—and of Frustrations

What is remarkable about the conference was not the ideas which were discussed —these for the most part have been around for some time. What *was* remarkable was the nature of the group which found that it had so much in common. True, the businessmen in attendance were not known as hidebound traditionalists, but neither were they from that group which has made a special point of being ostentatiously "concerned." These were serious people trying to deal with reality, and many of their ideas were consistent with values which I had thought were pretty much confined to the campus.

I left the conference late Sunday afternoon heartened by finding so many people in positions of responsibility "out there" who agreed (in principle, at least) with many of the ideas my contemporaries and I have had about the nature of the country's prob-

lems and possible courses of action. But there was a nagging feeling that a group like the Runnymede conference should and could do something about the state of the country and most of all the seemingly endless destruction of Asia.

But no plans had come of it; there was no consensus on courses of action. Was this because we all felt that we were doing more as individuals or because we all were caught in the feeling of frustration, helplessness, and impotence to control the institutions which govern our lives which paralyzes so many of us?

To answer that question, one must view potential actions of a hypothetical business-academic alliance in the context of current affairs. The quiet which has prevailed among antiwar groups since May has not been indicative of acceptance or support of the status quo, but rather of frustration and despair about the possibility of influencing government actions. Relatively few business leaders have actively opposed the war, but in the hiatus since May the confidence of many of them in the administration's "reduce the size of the war by increasing it" strategy has evidently worn thin, and Nixon has been unable to distract their attention by pointing to rioting students.

This combination of businessmen looking for a way to *do* something about American militarism and students who have learned the limits of what they can accomplish alone and seeking new strength through new allies seems to be a natural and promising relationship. Both share the common goal of getting the country back on the right track of striving to uphold and realize its stated principles. But the time is not yet right. Public awareness of the need to end the war is growing, but the public reaction has not yet reached the point of indignation which led to the Moratorium in the fall of 1969 or the events following the Cambodian invasion in May, 1970.

What is needed to create a climate in which action by a group such as Runnymede might be decisive, and what might that action entail? Again it comes down to trust, and the turn of events, the latter being substantially under Nixon's control. If he *genuinely* wants to withdraw completely from Indochina by the end of 1972, he will increase withdrawals, keep the level of fighting low, and maintain public confidence that we *will* withdraw. Under these conditions, there is little likelihood that a climate of opinion would emerge which would make possible Congressional action to end the war or a strong antiwar candidate—such as Senator McGovern —in 1972.

On the other hand, the "old" Nixon may continue to look for a quick fix from his military advisers. We will then see continued extension of the war, risking overt Chinese intervention, possibly followed by U.S. use of nuclear weapons. If this happens, or if a sufficient portion of the public simply stops trusting that something like this is *not* planned, an entirely different range of opportunities opens up. And to the extent that one distrusts Nixon's commitment to withdrawal, one is compelled to lay the groundwork now for such an eventuality. Hence the importance of meetings such as Runnymede.

Working alliances and trust between groups which heretofore have been considered antagonistic toward one another—such as the understanding which was forged at Endicott House—will play a key role in renewing the nation's political and institutional life, particularly concerning military policy. Only a broadly based alliance of Americans from all backgrounds —whether acting through an organization like Common Cause, backing a presidential candidate, or whatever—will have sufficient muscle to change and renew the country's outlook and policies. If such an alliance emerges, I will then know why I went to Endicott House that winter weekend.

Steven C. Carhart, President of the Class of 1970, is now a graduate student in the Program for the Social Application of Technology developing at M.I.T. under the direction of Carroll L. Wilson, '32, Professor of Management. He was instrumental in forming the M.I.T. Moratorium Committee at the time of the invasion of Cambodia in the spring of 1970 (see *Technology Review* for May, pp. 82-83) *and in the subsequent organization of the Movement for a new Congress.*

Mervin J. Kelly, 1894-1971

Mervin J. Kelly, retired President of the Bell Telephone Laboratories, Inc., who had been a Life Member of the M.I.T. Corporation since 1953 and Life Member Emeritus since 1969, died on March 18. James R. Killian, Jr., '26, Chairman of the Corporation, said that Dr. Kelly had been honored "nationally and internationally for his distinguished contributions to industry, education, and the nation.

"In countless ways he has unselfishly advanced the strength and quality of M.I.T.'s research and educational program," said Dr. Killian, "both as a trusted friend and adviser to M.I.T. presidents."

Dr. Kelly was a member of the M.I.T. Corporation Executive Committee from 1955 to 1966. He was National Chairman of the Committee on Corporate Leadership Gifts under the Institute's Second Century Fund from 1960 to 1963, and during that period more than 500 industrial companies pledged $27 million to M.I.T.—an effort which established "a wholly new level of corporate support at M.I.T.," Dr. Killian said.

Dr. Kelly studied at the Missouri School of Mines and Metallurgy, the University of Kentucky, and the University of Chicago, thereafter joining the Western Electric Co. as research physicist. He transferred to the Bell Telephone Laboratories, Inc., in 1925 and thereafter advanced through various research and development positions to become Executive Vice-President in 1944, President in 1951, and Chairman of the Board of Directors in 1958.

Technology, Capital, and Marketing as Ingredients of Enterprise

To build a better mousetrap is not the problem; the trick is to sell it. If you can do that, you can—as William I. Koch, '62, President of Koch Venture Capital, put it—"share the ecstasy" of being the entrepreneur of a surviving and even of a successful new business.

Mr. Koch was chairing the 1971 version of the Alumni Association's Cambridge seminar for young alumni on "How to Start and Operate a Small Business and Make It Grow." In his audience were more than 300 M.I.T. graduates, most of them less than 30 years old, who spent two long days on March 6 and 7 listening to presentations by nearly 50 entrepreneurs, venture capital experts, lawyers, and teachers on every "nuts-and-bolts" aspect of the topic.

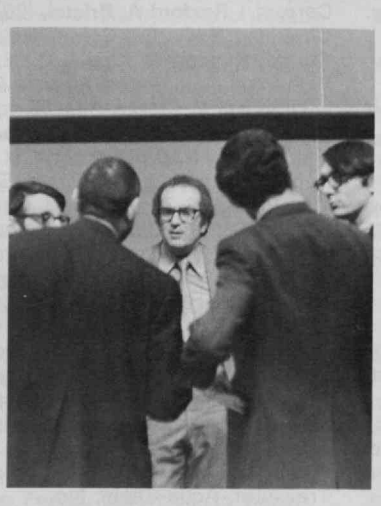
Despite Mr. Koch's and other speakers' emphasis on marketing as the key to success of a new enterprise based in new technology, most of the seminar's sessions were devoted to various aspects of what Richard Koplow, President of Business Equities, Inc., called "Parkinson's" Law of Venture Capital: expenses always absorb all available capital (the "law" is in the spirit but is not the work of Mr. Parkinson). The result is that every new firm tends to run out of money just when it most needs funds to launch the product on which the funds have been squandered.

Mr. Koplow's advice to would-be entrepreneurs founding their own companies: Make a simple, forthright financial plan for the company; let the financial plan fund operations, not risk; tie the financial plan to a schedule of time and results; get plenty of expert help—lawyers and accountants—on the financial plan; and, whatever financing the plan requires, get twice as much money as the need you project and put half of it in the bank and forget it.

"Parkinson's" Law of Venture Capital will catch up with that hidden half of your capital soon enough, said Mr. Koplow. Yes, said Thomas J. Davis, Jr., General Partner in the Mayfield Fund. "Every company I've ever invested in has had serious problems; you never go according to the chart," he said.

"An incredible number of problems" was how Thomas G. Wilson, '68, recalled the start-up period (Is that chapter of his life really finished yet?) for High-Performance Plastics, his year-old firm making fiberglas white-water canoes and kayaks. "It's not the technical problems—it's the management problems

If you think an alleged recession discourages the entrepreneurial instincts of M.I.T. alumni, think again. More than 300 came to the Institute early this spring to hear a repeat of last year's sell-out—a seminar on "How To Start and Operate a Small Business and Make It Grow." Speakers were surrounded by knots of enthusiastic discussants throughout the meeting; among the expert entrepreneurs: Edward B. Roberts, '57, Professor of Management, M.I.T. (top, center); William I. Koch, '62 (left), President of Koch Venture Capital, Inc., and Kenneth H. Olsen, '50, President of Digital Equipment Corp. (top, left); Richard S. Morse, '33, Senior Lecturer in the Sloan School of Management, M.I.T. (bottom,(left); and Raymond Frankel, '43, President of Technological Investors Management Corp. (bottom, right).



that will get you," he told his M.I.T.-alumni colleagues.

Wayne R. Matson, '64, whose Environmental Sciences Associates, Inc., has just begun to earn money after five months, said the criterion for success has to be that starting a small business is a labor of love—not a love of money. His hours are so long and his time at home so short, said Dr. Matson, that "even the dog doesn't recognize me any more."

Nor are stamina, plan, and idea enough. The successful entrepreneur, said Edward B. Roberts, '57, Professor of Management at M.I.T., is most likely to be a man in the middle of the spectrum: he wants to exercise responsibility, but he is willing to delegate decisions and function management functions. No matter what his training, the management part of the job—not the technology—will be the hardest.

In today's conditions of recession, can a new-technology enterprise really be funded, and can it possibly succeed? Yes, said Professor Roberts, who predicted a "major turnaround" in the venture capital market soon—from reluctance to willingness to invest in moderate risk. Growing demand in new fields, he said, will be as effective as defense demand has been in the past at stimulating commercially successful new technology.

In all, nearly a score of venture capitalists were speakers at various panels and workshops during the seminar. [All agreed with Mr. Davis: "Its people—the managers of technology, not the technology itself—that make the difference." A successful company must have "tremendous market orientation," he said. "Everyone from the president to the janitor must be anxious to sell."]

S.D.S. Goes Calling

Renewing the claim that M.I.T.'s Center for International Studies is engaged in research "designed to suppress popular revolutions," about 25 members of M.I.T.-S.D.S. marched to the Center after a noon-hour rally on March 15 with the avowed aim of "smashing C.I.S."

Everett E. Hagen, C.I.S. Director, and Eugene B. Skolnikoff, '49, Head of the M.I.T. Political Science Department, met the S.D.S. contingent at the Department's headquarters and engaged in a point-to-point debate for about 1½ hours.

Professor Hagen argued that the Center was an open research group that allowed no classified research and accepted no secret government funding. He insisted that S.D.S. was infringing upon the academic freedom of those working at C.I.S. and that the members of the Center had a right to their own views. Also, Professor Hagen maintained, they had the right to consult with the government or anyone else on their own time.

Earlier, S.D.S. had attacked several C.I.S.

Shades of 1969—but somehow it's different. The same formula which 18 months ago might have attracted several hundred protesters to M.I.T.'s Center for International Studies was used this spring by S.D.S. and the New University Conference: a rally denouncing C.I.S.'s role in opposing "world revolution," followed by a "march on" the Center. The words had the same sound, but only some 30 people were moved enough to make the march. (Photo: Joseph L. Kashi, '72)

faculty and researchers in a widely circulated leaflet, demanding a debate between S.D.S. and three political science professors associated with the Center: Ithiel D. Pool, one of the originators of the Cambridge Project (a program to apply computers to social science research data); Lucian D. Pye, author of *Guerrilla War in Malaya;* and Lincoln P. Bloomfield, author of the recently published *Controlling Small Wars.*

The protestors began their rather heated argument with Professors Hagen and Skolnikoff after being unable to find Professors Pye, Bloomfield, or Pool. Later, when Professor Pool arrived, the discussion shifted to his office. However, suspicion and distrust evident in both parties soon made an argument inevitable. S.D.S. called the C.I.S. researchers "war criminals" and "liars," while Professor Pool compared S.D.S. tactics to those of Nazis and other "anti-democratic groups." The protestors left Professor Pool's office about 3:30 after making preliminary plans for a public debate. Later in the week negotiations broke off after S.D.S. and C.I.S. reached an impasse over format, publicity, and time.

The episode dramatized both the lessened appeal of political actions this year and the split between various fending S.D.S. groups on campus. Less than 18 months ago, the C.I.S. issue attracted hundreds of students to the Center to talk for over three hours with researchers. This year far fewer came, perhaps because many feel impotent and drained after last year's massive political actions failed to produce many tangible results.—*Joseph L. Kashi, '72*

Alice M. Browne, 1896-1971

Alice M. Browne, Head Nurse of the Institute's Medical Department from 1925 to 1961, died on March 15, 1971, after a long illness.

Brownie, as she was affectionately known by nearly everyone, trained at Brooks Hospital in Boston under the direction of Dr. George W. Morse, Chief of Staff, who was also the first Director of the Medical Department at M.I.T. She retired in 1961, having served the Institute for over 36 years as Head Nurse, and for many years *the* nurse, of the Medical Department. In the following year the M.I.T. Alumni Association elected her to honorary membership, and at the same time she was made an honorary member of the Class of 1928.

In the words of Walter Smith, Secretary of the Class of 1928, "Many will remember Brownie with affection as the nurse who not only treated injuries but could be a student's confidante in time of trouble."

"Sweet" Greetings from '74

At the instigation of David Withe, President of the Class of '74, members of the freshman class greeted the Institute with a traditional Easter egg hunt on the Friday preceding Easter Sunday. The easter eggs—30 pounds of marshmellow eggs mixed with 90 pounds of jelly beans which the freshmen had sorted into 1,500 transparent plastic bags—were pinned to bulletin boards, desks, chairs, bushes and trees across the campus.

One was seen dangling from the fourth floor of the dome, another was pinned to President Johnson's office door. Each bag contained Easter and Passover greetings from the Class of '74 printed on old computer cards, "they were easy to get." President Johnson was "delighted" and so was the community.

Not all of the hiding places were obvious. A few bags were "really hidden away" and "probably won't be found for quite a while," the freshmen said. They also offered these additional statistics on their venture: it took seven boys and three girls three hours to bag the candy and two and a half hours to hide it; they estimate that the 30 pounds of marshmellow eggs equalled 3,000 pieces and that the 90 pounds of jelly beans contained about 12,000 pieces of candy.

Individuals Noteworthy

Richard J. Reed, Sc.D.'49, to President-elect, American Meteorological Society . . . **Richard L. Cheney,** '27, to President, Glass Container Manufacturers Institute . . . **Kenneth L. Block,** '47, to Vice-President, Institute of Management Consultants, Inc. and also to Chairman of Board of Directors, National Association of Citizens Crime Commission . . . **George T. Rooney,** '15, to honorary member of Boston Executives' Association . . . **John S. Bethel, Jr.,** '52, to Diplomate, American Academy of Environmental Engineers.

Willis B. Reals '47, to General Manager, International Division, Supply and Distribution Department, Texaco, Inc. . . . **William M. Ryan,** S.M.'64, to Manager—corporate planning, Industrial Nucleonics Corp. . . . **Kendrick B. Melrose,** S.M.'65, to Director—market planning, Consumer Products Division, Toro Manufacturing Corp. . . . **Guy W. Nichols,** S.M.'61, to President, New England Electric System . . . **Norbert E. Andres, Jr.,** '48, to Director—marketing, Advanced Digital Systems, Inc. . . . **George Wright,** '62, to Associate and **J. Karl Justin,** '48, to Vice-President and Director of Projects Administration, Max O. Urbahn Associates, Inc. . . . **Wayne Matson,** '64, to Vice-President and Technical Director, and **Alvin V. Block,** '49, to President and Chief Executive Officer, Environmental Sciences Associates, Inc. . . . **David R. Clare,** '45, to Board of Directors and Executive Committee, Johnson & Johnson.

Philip Dreissigacker, '37, to Vice-President—engineering and **Alan W. Sampson,** S.M.'59, to Vice-President—sales and marketing, Farrel Co., Division of U.S.M. Corp. . . . **Rexford A. Bristol,** '26, to Chairman, Executive Committee, Foxboro Co. . . . **Randall W. Kirk,** S.M.'52, to Vice-President, United Aircraft Corp. . . . **William F. Glaser,** S.M.'57, to Marketing Manager, Manchester Operation, Manchester, N.H., Raytheon Co. . . . **Robert P. Lofblad,** S.M.'60, to Executive Vice-President and General Manager, Wright Machine Corp. . . . **James T. Jeffries,** '59, to Assistant Division Geologist, Producing Department, Texaco, Inc. . . . **Norman Siegler,** '56, to Corporate Controller, Ideal Toy Corp. . . . **Robert B. Nickerson,** '51, to Vice-President and General Manager, The States Co. . . . **Allan Elston,** '51, to Vice-President—European operations, Pillsbury Co. . . . **Jerome E. Vielehr,** '56, to Vice-President of Finance and Secretary-Treasurer, Aqua-Chem, Inc. . . . **Andrew**

D. R. Clare, '45

W. M. Ryan, S.M.'64

W. Matson, '64

K. L. Block, '47

A. T. Ling, '50

W. B. Reals, '47

T. Ling, '50, to Director, Advanced Development Department, Xerox Data Systems . . . **John G. Borger,** '34, to Vice-President and Chief Engineer, Pan American World Airways . . . **Thomas O. P. Speidel,** S.M.'57, to Director—engineering, Lodding Engineering Corp.

To **Holt Ashley,** S.M.'48, the Fiftieth Anniversary Medal, American Meteorological Society . . . To **H. Rush Spedden,** '50, the 1971 Robert H. Richards Award, American Institute of Mining, Metallurgical and Petroleum Engineers . . . To **Winthrop Moorhead Leeds,** '39, the 1971 Lamme Medal, I.E.E.E. . . . To **Gilbert G. Lorenz,** '34, Technical Director, Army Engineer Topographic Laboratories, a certificate of recognition from the Department of the Army . . . To **Arthur F. Peterson,** '44, the 1971 Charles F. Rand Memorial Award, American Institute of Mining, Metallurgical and Petroleum Engineers . . . **Walter J. Humann,** '59, named one of Ten Outstanding Young Men of America, U.S. Jaycees.

Richard H. Battin, '45; **James A. Fay,** S.M.'47; **Joseph Gleason Gavin, Jr.,** '41, to Fellows of the American Institute of Astronautics and Aeronautics . . . **Massimo Baer,** '40, to Senior Science Fellow, Monsanto Co. . . . To **John C. Johnson,** S.M.'46, award of recognition from the National Weather Service . . . To **Roger Chang,** '69, the Hickernell Award of the Institute of Electrical and Electronics Engineers . . . **Thomas B. Hayes,** S.M.'40, and **Hazen E. House,** '29, to Fellows of the Institute of Electrical and Electronics Engineers . . . To **Francois Rousseau,** '27, the Julian C. Smith Medal and to **Dominique M. Mascolo,** '66, the Ernest Marceau Prize, the Engineering Institute of Canada . . . To **Egor P. Popov,** S.M.'34, the 1971 Theodore R. Higgins Lectureship, American Institute of Steel Construction . . . **To Abraham Woolf,** '28, the Man of the Year Award from the Brotherhood of Temple Beth Zion, Brookline, Mass. . . . To **R. Anderson Pew,** S.M.'70, the R. Kelso Carter Award from the Alumni Association of P.M.C. Colleges . . . **Arthur A. Wasserman,** Sc.D.'51, to Fellow of the American Institute of Chemists . . . **Harrison E. Rowe,** '48, to Fellow of the Institute of Electrical and Electronics Engineers . . . **John Linn Forbis,** M.A.R.'65, to Baker Scholar, Harvard Graduate School of Business Administration . . . To **Bernard M. Gordon,** '48, General Partner of Gordon Engineering Co., the New England Award from the Engineering Societies of New England

Alumni Calendar

Baltimore—June 2, Wednesday—Dinner meeting. Speaker: Walter Sondheim, Jr. Topic: The Metro Center Plan for Baltimore.

Boston—May 26, Wednesday—Scenic Cruise around Boston Harbor with a buffet dinner served aboard the Bay State Boat at 6:30 p.m. followed by a tour of the New England Aquarium.

Chicago—May 13, Thursday, 6:30 p.m., Jacques Restaurant—Dinner meeting, honoring James R. Killian, Jr., '26.

Dayton—May 4, Tuesday—Dinner meeting at 5:30 at the Ramada Inn-Stratford. Speaker: Dean Robert A. Alberty. Topic: Has the Campus Really Quieted Down—What is the Current Picture at M.I.T.?

Long Island—May 21, Friday—Annual dinner meeting at the Milleridge Inn, Jericho, at 6:00 p.m. Speaker: Vice Admiral A. F. Schade, Commander of Eastern Sea Frontier.

—June 5, Saturday—Annual Picnic.

Miami—June 17, Thursday—Annual Meeting.

New York—May 11, Tuesday—M.I.T. Chamber Music at Carnegie Hall at 8:30 p.m. with M.I.T. faculty and students as composers and performers. Informal reception for the musicians in Cafe Carnegie immediately following the concert.

Northern New Jersey—May 18, Tuesday—Annual dinner meeting at the Robin Hood Inn, Clifton at 6:30 p.m. Speaker: Irving M. London, Professor of Biology and Director of the M.I.T.—Harvard Program in Health Science and Technology. Presentation of the Outstanding Alumnus Award will be made.

Portland, Maine—May 6, Thursday—Dinner meeting at 6 p.m. at the Holiday Inn. Speaker: A. Scheffer Lang, '49, Professor of Civil Engineering. Topic: Analysis of Transportation Systems.

Cambridge—May 1-2, Saturday-Sunday—Alumni Seminar on "Providing Energy for the Future"; registration before 9 a.m. at Room 26-100, M.I.T.

—June 4-6, Friday-Sunday—Class Reunions at M.I.T. and other locations.

—June 6, Sunday, 9:30 a.m.-5 p.m.—M.I.T. Student Center, Conference for Club Presidents.

—June 6, Sunday—M.I.T. Night at the Pops.

—June 7, Monday—Homecoming Day.

Commencement Plans

Commencement activities for the Class of 1971 will be conducted on the M.I.T. campus on June 3 and 4 in a format which promises—at least at this writing—to be entirely conventional. The highlight will be Howard W. Johnson's last formal appearance at an M.I.T. academic event as President of the Institute; he will address the Class and guests at the Graduation Exercises in Rockwell Cage, beginning at 10:30 a.m. on Friday.

The two-day celebration is to start on the previous day with Commissioning Exercises for members of the graduating class completing R.O.T.C. requirements. The Class of 1971 will sponsor a general meeting for the entire community that afternoon, and they will host parents and faculty at a Student Center informal party Thursday evening.

The traditional Commencement Luncheon in M.I.T.'s Great Court will follow the Graduation Exercises—and thereafter the President's receiving line for graduates and their guests. Members of the Class of 1921—50 years graduated—will be the Institute guests at the Commencement events.

Deceased

Etheredge Walker, '99, January 12, 1971
William C. Arsem, '01, February 11, 1971
William H. Conant, '04, February 24, 1969

Talent Available

These announcements are published in *Technology Review* without cost for graduates of the Massachusetts Institute of Technology who have registered their interest in new professional opportunities with the Institute's Alumni Placement Office. Such alumni are invited to submit statements, not exceeding 50 words and including relevant details of field and date of degree, professional experience, and interests to the Editor, *Technology Review,* Room E19-430, M.I.T., Cambridge, Mass., 02139. Each announcement will be published in a single issue of the *Review*; subject to the availability of space, announcements received by the 25th of each month will appear in the *Review* published five weeks later. The identity of advertisers will not be revealed either in print or in correspondence; respondents' letters, addressed to the appropriate key number at *Technology Review,* will be forwarded unopened to the advertiser.

Executive: accomplishments include building profitable company from $1.6 to $25 million annual sales; developing, manufacturing and marketing new products on time; designing and building production equipment to yield annual savings of $175,000; and eliminating threat of a union takeover. Key MAA1.

Microwave tubes and development: S.B. in electrical engineering, S.M. in physics, 18 years experience in program analysis, Fortran (five years), assembly, and related activities. Now in Los Angeles, seeks position in or out of these fields, any location; salary open. Key MAA2.

Aeronautical engineer with "can-do" attitude seeks engineering and/or administrative position in small, commercially oriented company. Age 27. Ph.D. with only 5½ years total residence at M.I.T. and Caltech. Three years research and development experience, some marketing experience. Good writer. Can obtain venture capital for new business. Los Angeles area only. Key MAA3.

Electrical engineering: one year of experience in magnetic thin films research, correlating fabrication with performance and designing tests. Strong on field theory; also solid background in neurophysiology, designing and running experiments, data analysis, Fortran. German. Lathe and drill press. Seeks research and development challenge, Boston area. Key MAA4.

General management in technical company: unusual ability to develop and implement overall business concepts. Combination of engineering background and entrepreneur's outlook key to providing sound business approach in smaller technical company or guiding new product program for larger company. Background in chemical and pollution control industries. Key MAA5.

Operations research and analysis: Challenging position wanted with government agency or consulting firm in transportation planning or other aspects of urban planning. I have broad training in operations research and economic analysis, and four years' experience in a major regional transportation planning project, with emphasis on new comprehensive ways of evaluating public investments. Key MAA6.

Engineering: S.B.'52, S.M.'53. Desire position with small engineering and/or manufacturing firm. Would consider investment or part ownership in right situation. No geographical limitations. Degrees in aeronautical engineering, experience primarily aerodynamics—some supervisory. Hobbies have developed machine shop and welding experience. Some marketing experience. Would prefer not aerospace oriented. Key MAA7.

Manager: S.B.'70 in management and behavioral science. Experience with Bell System Outside Plant and Engineering in the IMDP program. Also experience in publications and food service. Seek general line management position, New England preferred but not necessary. Key MAA8.

Mechanical engineer: Ph.D. with broad experience in teaching and aerospace research. Have published and invented. Seek university teaching with research opportunities in mechanics/applied mathematics/thermodynamics. Have and will teach overseas, developing countries, etc. Key MAA9.

Materials engineer: S.B. in mechanical engineering, S.M. in metallurgy, Reg. Prof. Eng., 23 years supervisory experience in product and material development, design, cost reduction, quality control, metallography and mechanical testing. Desire position in material, power, environmental, or product development field. Key MAA10.

Mechanical engineer: S.B.'61, Sc.D.'71; diverse experience in mechanical design, testing, measurements, inertial instrumentation for navigation and seismology. Position wanted in engineering teaching or in instrumentation, mechanical measurement, or design; or museum work in history of industrial technology, history of transportation. Key MAA11.

All around engineer: Non-defense industrially oriented chief engineer, electrical and mechanical; S.B.'52, candidate for M.S. in computer science; registered professional engineer; line, staff and project supervisory experience from negotiation thru acceptance testing of automated custom designed machinery; heavy background in metal working with exposure to various other process industries. Seeking position with growth potential. Key MAA12.

Mechanical engineering: Three active years with high- and ultra-high-vacuum systems, designing the latter. Research experience: cyclotron operation, image intensifier performance, X-ray filters. Skills: miller, lathe, drill press; test fixture design; machine language; photomacrography; fluent French; creativity and hard work. Seeks mechanical/optical design, Boston area. Key MAA13.

Systems—Instrumentation: S.B. and S.M. in electrical engineering, eight years immediate project responsibility with major research organization in chemical-petroleum field on projects involving problem analysis, program generation, equipment or system development, initial field tests, reporting and follow-up. Broad background includes special research, pilot plant and auto emission instrumentation. Will relocate. Key MAA14.

Starfleet science officer: S.B.'66, seeks position with growing, dynamic enterprise. Prefers long, hard, irregular hours, unusual and difficult problems, and a piece of the action. MAA Key MAA15.

Ernest S. Altgelt, '07, December 24, 1970
Andrew W. Hull, '07, February 8, 1971
Harry C. Lord, '08, February 25, 1971*
Harry H. Catching, '12, March 2, 1971*
Linwood D. Faunce, '14, February 8, 1971
Henry C. Adams, '15, February 1970
Samuel W. Armistead, '15 n.d.
Benjamin Hurvitz, '15, February 13, 1971
Huet Massue, '15, June 1970
George F. Nixon, '15, February 21, 1971
William W. Stephenson, '15, February 13, 1971
Walter G. Tirrell, '15, September 1970
Freeman Clarkson, '16, February 27, 1971
Irving C. Eaton, '17, December 22, 1970
Harry L. Katz, '18, January 14, 1971*
Frederick W. Pennoyer, '20, January 21, 1971
John F. Ryan, '22, February 25, 1971
Richard D. Ferguson, '23, December 6, 1971
Henry Flynn, '23, February 10, 1970
C. Sumner McCann, '23, March 19, 1971
James J. Hairston, '24, August 4, 1970
Charles E. Geisler, '25, December 3, 1970
James R. G. Hardy, '25, February 10, 1971*
Della V. Egan, '26, February 4, 1971
Alice M. Browne, H. M. '28, March 15, 1971*
Harold L. Halpert, '29, January 10, 1971
Frank W. Horn, '29, August 25, 1970*
Lee J. Schnackenberg, '29, March 8, 1971
Charles W. Maskell, '30, February 23, 1970
Dana C. Hathaway, '32, November 2, 1969
Morris N. Green, '33, March 3, 1971
John T. Burwell, '34, March 11, 1971*
Robert G. Henry, Jr., '34, December 17, 1971
Ambrose S. Higgins, '35, March 24, 1971
Arthur K. Baker, '36, February 4, 1971
Philip F. Clark, '36, March 10, 1971
Robert E. Sawyer, '36, October 11, 1970
H. C. Adams, Jr., '37, February 1970
George H. Stoner, '40, February 28, 1971
Charles W. Gunnels, Jr., '49, April 27, 1957
Donald P. Clavin, '57, January 16, 1971
*Further information in Class Review

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Class Review

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I am sending this report to keep '95's record. Sorry I do not have anything of real interest, being the last '95 man.

Due to the hard winter, I did not get out very much but am looking to Spring hopefully, although my legs are not what they were!

Springtime Greetings to all.—**Andrew D. Fuller,** Secretary, 1284 Beacon St., Brookline, Mass. 02146

96

Did any of you chance to see the article "Sails, Ships and Cargoes" in the March issue of *Down East* magazine? It told the story of the century old company of Dunn and Elliot of Thomaston, Maine. In the days when Maine ships and sails were found on the seven seas, this was a shipbuilding, sailmaking and ship owning business. Under the astute management of a member of this class, **Richard O. Elliot,** it was converted to one dealing with fuel and electrical appliances. He was president of the concern from 1918-1928 and then turned his interest to banking. The last ship launched (1920) was a sleek five-masted schooner which was shown in one of the many photographs.

A local paper interviewed Mr. Elliot at his home in Thomaston just before this article was released. It reported that he is enjoying his retirement and still has an active interest in business and civic affairs. He has grandchildren who are grandparents and so has been privileged to see his family to the fifth generation.—**Clare Driscoll,** Acting Secretary, 800 4th Street S.W., Washington, D.C. 20024

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Your secretary is arriving home this month after eight months of trailering with husband, Harold. We stayed in Mexico until the last of February; then in Texas and Florida. We galloping grandparents are of the age when warm weather is acceptable the year around.—**Mrs. Audrey Jones Jones,** Acting Secretary, 232 Fountain St., Springfield, Mass. 01108

08

It is with most sincere sympathy that we report the death of **Harry C. Lord** (84) on January 25, 1971, at a St. Petersburg hospital in Florida. Harry was born in Lynn and lived in Lowell for 26 years. He graduated from M.I.T. with the Class of 1908 and was a member of the Beta Theta Phi fraternity. He was also a member of the Rising Sun Lodge AF and AM of Nashua, Bektash Temple in Concord, N.H., the American Society of Professional Engineers and the Plant Club. He took over John A. Stevens Engineering, Inc. of Lowell and became its president. Following his retirement from the firm in 1952, he made his winter home in St. Petersburg in sunny Florida. Graveside committal services were at Pine Grove Cemetery, Lowell.

Harry leaves his wife Amy (Venn), two daughters, Mrs. Virginia Goward of Lowell, Mass., and Mrs. Barbara Moore of Bethesda, Md.; two sons, Harry C., Jr. of London, England and Robert of Chelmsford, Mass.; two sisters, Miss Clara Lord of Lynn, Mass., and Mrs. Margaret Locker of Elmira, N.Y. and two brothers, Kenneth of Lynn, and Ralph of Pompano Beach, Fla.—**Joseph W. Wattles,** Secretary, 26 Bullard Rd., Weston, Mass.

11

It is not too late to get in on our Sixtieth Reunion. If you have not already done so, fill out the application blank you recently received from the Alumni Office.

From a fine long letter from **Oliver Powell** of Glendale, Calif., I gathered the following: The Powells will not be at the reunion as it conflicts with their fiftieth wedding anniversary which they are celebrating with their family and friends. Oliver and Dorothy were married in Oak Park, Ill., with our classmate **Marcus Grossman** as best man. During their many happy years together they have had two children—Louise, who lives in Doylestown, Pa., and Robert of San Rafael, Calif., and six grandchildren. After twenty-three years in Auburn, N.Y., the Powells moved to Glendale in 1943. Oliver spent a few years with Lockheed and then went into the supply department of the navy at U.S.M.C., El Toro, as a management engineer.

Since retirement in 1964, the Powells have done a good bit of traveling. In 1965 they drove 15,500 miles to Oklahoma City, New Orleans, Key West, Philadelphia, Boston (where they joined in the Alumni homecoming in June), through the Maritime Provinces to Quebec, back to Boston and on to Chicago, Winnipeg, Jasper, Victoria and home. In 1966 they cruised the Inner Passage to Alaska and in 1967 visited Yellowstone and the Grand Tetons. In 1968 to Philadelphia and Florida where they spent ten days driving around the state, then a week on a Caribbean cruise. Then in 1969 it was a flight to Hawaii for the year-end holidays.

After many years in Boy Scout activities Oliver has now retired from them and was awarded a plaque and honorary membership by the Toastmaster's Club in Santa Ana. During his days in Auburn he worked closely in scouting with our classmate **Howard Ireland.** Now Oliver goes nearly every day to the fine Glendale public library which will soon have a four-million-dollar new building. His copies of the *Technology Review* wind up in the library reading room. He extends best wishes to all Eleveners and would be happy to see any who get out in his neighborhood.

Roy MacPherson has had his boat pulled out at the Town River Yacht Club which is about a mile and a half from where I live. On a recent visit to look after the well-being of the boat, he came around and called on me, much to my delight. We talked about the reunion and he is going to be there for part of it. He does not like to leave his wife, Ina, alone for long as she is handicapped, having been out of the house only twice for trips to the hospital in the past year.—**Oberlin S. Clark,** Secretary, 50 Leonard Rd., North Weymouth, Mass. 02191

12

At this writing we are in Florida and it is still winter up north. I recently attended a luncheon of the Southwestern Florida M.I.T. Club in Sarasota with some 60 men present, including **Paul Tyler** and **John Lenaerts.** The speaker, L. J. Keller of Kinetics Corp., Sarasota, gave an excellent talk, describing the Minto automobile engine, which is now being developed, and is a modern version of the old Stanley steamer. It burns kerosene as a fuel, which boils a refrigerant liquid-like freon thru a heat exchanger, with a motor which is a cross between a piston engine and a turbine. It greatly reduces both thermal and noise pollution. Currently, the engine is being licensed to various auto makers.

Howard Cather was unable to take his trip to Florida as planned due to a death in his wife's family. . . . **Harold Brackett** arrived in mid-March at Longboat Key and we have enjoyed a visit with him and his niece, Elinor Forbes. . . . We are glad to learn from **Arch Eicher** that his health has sufficiently improved so that he and Julie were able to take a trip to Riviera Beach on the Florida East Coast this winter. . . . **Luis Gonzalez,** Course II, recently moved from Santurel back to his former home in San Juan, Puerto Rico. His address is GPO Box 2222, Zip 00396. Luis is confined to a wheel chair and we are sure would welcome letters from any classmates.

Willis Salisbury was our only representative at the 1970 Fair in Japan. He writes: "I arrived in Osaka by ship after a 14-hour trip covering the entire length of the Inland Sea. Now I was ready to see the Fair, just crowded with people—the paper said 351,000. First, I rode about the entire area on the free monorail train to get oriented. Then I selected a number of exhibits which did not seem to be too crowded. There were very few Caucasians, and Americans were scarce. By four o'clock, I had had enough walking and after some difficulty with trains, I reached my hotel. The next day I was invited to inspect a large metal working factory, owned by relatives of my friend, Yukata. They produce heavy lathes and shapers which have a worldwide market. After an interesting trip, we had tea and I was presented with a gift. Now back to the Fair. I started next day at 7:30 a.m., but found that only groups were admitted early, so I had to wait two hours watching groups of as many as a thousand. When I did get in, I ran to the U.S.A. building but found some 3,000 people lined up ahead of me. I entered about eleven o'clock. The exhibit was excellent, much better than Expo 70 in Montreal. I was proud of the whole U.S. show, especially the exhibit of the moon ship and equipment.

"I left the Fair at noon for Mt. Fuji where I had been invited for a few days as a guest of friends, who are part owners of the lovely Fukiya Hotel in the mountains. I walked about the beautiful gardens and hiked up the mountain beyond. Then enjoyed a bath in the hot mineral springs. I had an American dinner in the home of my friends and the next evening they served a sukiyaki dinner, Japanese style. They took me on a tour to see the five lakes on one side of Mt. Fuji. There were spectacular views all the way: clouds, lakes, the large cherry willows, a ski resort and two golf clubs. We lunched at Fuji View Hotel. Another day we boarded a hanging cable car which took us on a four mile aerial trip to another mountain. Here we lunched on the side of a lake. We drove back, but continued fogs still prevented us from seeing *the mountain* so we took to the other side and saw some unusual outdoor abstracts at a museum. Sculptures were cut in large blocks from different rocks. There were also some exhibits made from steel shapes. The whole exhibit covered many acres on a mountain side. However, I had soon 'seen it enough.' The next day, I left my good friends for the big city of Tokyo. Here I spent five days enjoying the many sights of this very modern and busy metropolis and particularly liked the famous copy of the Rockette show in Rockefeller Center Theatre. One day happened to be the Emperor's birthday, and effective precautions were taken to discourage possible rioting. Many crash-helmeted police patrolled the streets, carrying shields some four feet in height. My wonderful trip was now over and I took the plane to Seattle and then home." Thank you, Willis. Tell me, how do you do it?

We have a letter from **Dolphe Martin** on his return from a trip to London, giving additional information on his unusual career which was outlined in the January issue. Dolphe became a violinist as a child and during high school and at Tech, earned his tuition playing in orchestras and later, conducting an orchestra of his own. He became most successful in this work and by the time of his graduation from Harvard Medical School, he was conductor and impresario for several orchestral groups, so that he decided to continue rather than practice medicine. His orchestra, known as "Doc Eisenbourg and his Sinphonians," was heard daily on Station W.N.A.C. in the early days of radio. He conducted and arranged the music for his own orchestral group on a national Christmas broadcast series with several outstanding musicians who later had orchestras of their own. He created the "voice orchestra," using voices, not instruments, performing orchestrally. Having a medical background, he decided to open a school in Boston under the aegis of the Veterans Administration, with courses for the rehabilitation of emotionally disturbed veterans through the application of music and drama. This innovation in therapeutic teaching proved highly successful even in advanced cases. These courses, combining music and psychology, were soon expanded to include normal students as well as those emotionally disturbed and the West Roxbury Academy was established most successfully. Dr. Martin headed the department of specialized training for emotionally disturbed youngsters. A most unusual and interesting career. Our congratulations to you, Dolphe Martin!

I am sadly reporting the death of **Harry H. Catching,** Course I, in Lexington, Ky., on March 2, 1971. Harry had not been well for some time, but the end came quite suddenly. His life history appeared in the January 1970 issue of the *Review* in which he tells the story of the scale model of the 1890 Louisville W.W. steam pumping engine he built and donated to the Smithsonian Museum in Washington. Harry was in the building construction business for most of his career and built many government and school buildings, as well as many roads throughout the South. We have expressed the sympathy of the class to his wife, Doris.

Our sixtieth reunion is only thirteen months away and we should all be thinking about this very special occasion. It will not be long before you will hear officially from our president and reunion committee chairman, **Al Davis.** We are hoping to have an attendance of at least thirty enthusiasts, together with many wives. We are presently planning to hold the gathering on the M.I.T. campus where rooms will be provided by the Alumni Association in McCormick Hall. The possibility of meeting at a hotel on Cape Cod has been considered but we have abandoned the plan due to transportation difficulties caused by extreme traffic on the Cape Cod highway. On weekends particularly, bumper to bumper conditions can regularly be expected. . . . News from our classmates is still scarcer than hen's teeth. Your contribution is badly needed—**Ray E. Wilson,** Secretary, 304 Park Ave., Swarthmore, Pa. 19081

13

Time stops for no one. Many of us of 1913 have retired and are enjoying ourselves in various parts of the country, mostly in Florida or California. Roz and I have placed our home in Canton for sale. We expect to build our "retirement home" in Biddeford, Maine. Our older daughter, Janet, and Raymond Ruder have their home base there, and they have asked us to take over the lot next to theirs, which we are planning to accept. We shall become "Mainiacs" soon after June 1, we hope.

Fred Lane writes, "Here, finally, is a copy of the pertinent part of the *Baltimore Sun* for Jan. 20, 1971. Sorry it took me so long to get it, but the only place they are available is at the main plant of the paper in downtown Baltimore. Hope it meets your needs." He was referring to the recent article about **Marion Rice Hart.** . . . A very nice letter has been received from **Clarence Brett:**

"Many thanks for your letter of January 11, with which you enclose your report regarding **Bill Mattson**'s visit with us in Mesa. We had the pleasure of another visit with Joe and Bill just before Thanksgiving. It seemed like old times to get together again. We only wish that the Capens would drop in for a visit and enjoy some of the Arizona sunshine that we are having now. Garnet's family lives in Illinois and that general vicinity, while mine is in Massachusetts and New Jersey. That's a long way off and altho we had the pleasure of visiting them this last summer, we don't know just when we will be able to make the circuit again. If by chance we get in your neighborhood, we will make it a point to try to look you up."

Dave Nason is again in Barbados for his usual winter fishing trip, and he sends the following message "Herewith, your annual card. Consider yourself honored. My best to you and class members who still count their birthdays."

Mrs. Dorothy Stillman supplies us with certain details about our classmate, **Fred Stillman,** who passed away January 14, 1971: "Thank you for your sympathy. I shall try to fill you in on some of Fred's activities since he left M.I.T. He was a metallurgist at the U.S. Metals Refining Co. in Carteret when I met him in 1925. In 1937 he became a 'night supervisor' there until his retirement in 1953 at the age of 65. During his retirement his hobbies were photography, repairing televisions and radios, and travelling. We travelled through all the 48 states, Mexico, and Canada. We had a long, happy, active life together. Fred passed away January 14 at the age of 82, after a short illness. If there is anything else you wish to know, please let me know and I shall try to answer you."

It was very gratifying to receive the literature regarding "Doc" Lewis, who is still very active. "Doc" was my advisor both in chemical subjects as well as raising chickens (the feathered type), in which we both were interested. . . . We have been very much pleased with the efforts of our present President, Paul V. Keyser of our Alumni Association. First, he really communicated with us of the Alumni regarding our views and choice of a new President of M.I.T., namely Dr. Jerome B. Wiesner and the selection of Dr. Paul E. Gray as Chancellor of the Institute. Secondly, we appreciate Paul's endeavors to keep us of the Alumni Association notified of the plans and activities of the organization. . . . To Brenda Kelley and Kathy Sayre congratulations on their "up-stage musical chairs." . . . Keep well and busy. —**George P. Capen,** Secretary-Treasurer; **Rosalind R. Capen,** Assistant Secretary, 60 Everett St., Canton, Mass. 02021

15

Indeed, The Class Supreme, indeed, for altho' this biennial collection of our modest class dues is a time consuming, detailed and worrisome job, it has its rewards. For, as I look at and record the many checks from all over our country and Canada, I am reminded of the men who sent them. Many are classmates I have not seen for over fifty-five years, whom I would not know now, even if I saw them. Their interesting letters, which follow with excerpts from some **Ben Neal** has received in the same vein, are very touching. This is a unique feeling of interest and pride on their parts in our Class and a sincere desire to be a part of it and to support it. It all moves me with a warm and friendly feeling. Many thanks to you all.

Phil Alger: "I think the way to appeal to old-timers for Alumni gifts is to suggest leaving bequests in one's will. Those who have not given for 55 years should have a nagging feeling of guilt which will *not* lead them to change their ways, but just persuade them to make an atonement of some kind. I had breakfast with **Fred Vogel** in New York on February 2 and saw him given the I.E.E.E. Habirshaw Award. He is very well and chipper, but is fully retired, and living in Florida. He said he does plan to attend our 60th reunion, d.v. as I do." Congratulations to Fred for this high honor. The citation reads: "For outstanding contributions to electrical equipment development, electrical insulation technology, and industry standards resulting in increased reliability and major economies in a-c transmission and distribution systems." Fred is a member of the Episcopal Church and has been active in Masonry for most of his adult life. His hobbies include the piano, which he has played since a young man, and in recent years the electric organ. He has long had an interest in photography and still enjoys golf and bowling. Both he and his wife are able and enthusiastic bridge players.

From L. A., **Frank Boynton** wrote that he suffered no damage from the well advertised earthquake and that none of the numerous school buildings which he helped to rehabilitate after the Long Beach quake of 1933, was damaged.

Larry Bailey's wife, Gladys, died March 5. Representatives of the Class attended the services to express our sympathy and feelings for Larry. He wrote: "My son Robert, M.I.T. '41 has a very shaky job with I.B.M. in Washington. Meteorology programs have lost government support but he is hanging on there and taking training in computer programming. My two granddaughters are OK. The younger one is a stewardess on Pan Am and has done a lot of travelling. The other granddaughter married a few years ago and has presented us with a great-grandson!"

Wer'e sorry to hear the sad news about **Ralph Hart** in a letter **Sam Berke** wrote to Ben: "As you may know, I went to grammar school with Ralph Hart and so I have known him a long time. During the last four months I have spent about one week a month in New York and during each visit I tried to find out how he was getting along. Last week I had a chance to talk to his brother Abe and the news was not good. He is in the DeWitt Nursing Home in Manhattan with nurses round the clock, and Abe asked me not to see Ralph." . . . **Bill Brackett:** "Your appreciative letter for the donation I made to the Alumni Fund arrived at about the same time as a plea from our Secretary for *funds.* I wonder where he is planning to travel. Anyway I look at it it is money well spent, for a good cause. It is always pleasant to hear from you, Ben, because it is after the donation is made. I have the Class Supreme 55th Reunion picture on my bedroom wall right at my dresser where I have to look frequently to brush my shock of hair. The rest of the walls are papered with the other pictures at Reunions over the years. By the way, after getting Azel's heart rending request for funds I am sending him my rubber dues check that should dry up his tears."

Orton Camp: "I retired from Platt Brothers three years ago. I would probably have retired sooner but for the fact that we were hard hit in the Flood of '55 and it took us several years to get back on our feet, as we were almost completely wiped out, both buildings and machinery. Instead of completely retiring, I have worked into a part time job in real estate and keep comfortably busy although I am not tied down to long or fixed hours and I do get away for short vacations. We plan to go to Florida the middle of March but usually only stay two weeks as that is all we want. We enjoy the winter here in Middlebury even when it is somewhat rugged, as it has been so far this year."

It's good to know **Jack Dalton** has had a comfortable winter in Florida. To Ben: "We seem to have picked a pretty good winter to be away from Cambridge and Sharon, N.H. Not much excitement here but a very pleasant comfortable way of living to avoid ice and snow. You do a great job keeping in touch with our Classmates and their Fund interest."

Ray Delano: "As you know I have been a widower now for about three years and of course have had to become reconciled to a somewhat new way of life. I live alone and do my own housework. When I get tired of my own messes I go out to eat. Up to this point in my life, and I am pushing 80, my health seems to be good. I have two sons and six grandchildren who live close by so that I am entertained at their homes quite often. I have a shop or garage where I have several machine tools, such as a South Bend lathe, bench saw and joiner and drill press etc. What this all amounts to is this, I repay hospitality by running a 'make it' or 'fix it' shop and believe me I get some missions that are damned near impossible. However, all this and what reading I do keeps me busy and I think all of us of our age who are fortunate enough to have reasonably good health and are able to keep busy have a lot to be thankful for. I marvel

at the way *you* and the 'Pirate' and the others keep the 1915 Class spirit alive and active. I think you both deserve much of the credit for it." . . . **Ellis Ellicott:** (We hope when he reaches Martha's Vineyard he can reunion with **Charlie Norton.**) "We live a very quiet life here, no excitement. We did take a trip in September-October of last year, it was under the auspices of Alumni Flights Abroad and they did a fine job. We went to Hawaii, Tokyo, Bali, Singapore, Hong Kong, Tokyo, Hawaii and then home. This agency limits its clients to Harvard, Yale, Princeton, M.I.T. and Amherst graduates, although I hear that University of Pennsylvania just made it. We were a very congenial group, 29 all told, including an M.I.T. couple, Neal Karr '34 and wife Dorothy. We are planning about a month in Ireland, Scotland and England in May, and probably a few weeks at Martha's Vineyard in August."

George Easter wrote that it cost him $180 for four to five hours of snow shovelling at his camp in the Adirondacks. The snow on his back porch roof was four feet deep. Better go south, George. . . . **Louis Finck:** "I was in Course VIII, Physics. I am retired from my thermodynamics laboratory, but retain an interest in my field. I have three married daughters, two of which are living in Israel. Total, 11 grandchildren. I spend some time each year in Israel, and in that way keep in touch with my family." . . . From way down East in Ellsworth, Maine, **Deoch Fulton:** "I am trying to survive Maine's worst winter." Br-r-r! . . . **Francis Hann,** a retired attorney in Beverly Hills: "It's been a long time since 1915. Best regards to all."

Now, to interrupt this alphabetical sequence, I want to give you this very funny letter from **Louie Young,** accompanied by a whopping big check for his dues. It sounds typical of Louie. It rocked me with laughter. "Not much news except I am still Vice President. Pauline is President. I was surprised to find that I had received a mention in Van Bush's book *Pieces of the Action* (page 265). During those teaching days I was giving the lectures in Freshman Physics. I had carefully prepared a lecture on the visible spectrum and had devised some experimental illustrations which were performed in darkness. In the midst of these I heard faint clicks coming from the floor just in front of the lecture platform. I recognized these as pennies. I turned on the lights and shouted 'The S.O.B. that threw these pennies hasn't got guts enough to pick one up.' No one showed up but I did get applause. This happened just after Karl Compton was appointed. After the lecture I was called to his office. He said, 'I was at your lecture this morning. It was very good. You have a most unique way of maintaining discipline.' "

It is sad to report these deaths: **Henry C. Adams,** February 1970; **Samuel W. Armistead,** no date; **Ben Hurvitz,** February 13, 1971; **Kenneth W. Roy** January 3, 1971; **William W. Stephenson,** February 13, 1971; **Walter Tirrell,** September, 1970; **Huet Massue,** Montreal, June 1970. The sympathy of our Class goes out to the families and relatives of these men . . . Keep those dues and newsy letters coming to "help you know who."—**Azel W. Mack,** Secretary, 100 Memorial Drive, Cambridge 02142

16

A good letter to Harold Dodge from **Arvin Page** brings us up to date re the Squire of Winston-Salem: "I regret that I failed to meet your suggested deadline, that is not actually true as I rather glory in my ability to thumb my nose at all such. When it comes to meeting deadlines I will probably continue to violate all of them that are not of vital importance. For forty years I was so thoroughly browbeaten and dominated by deadlines that I have become allergic to them. However, in this case, and similar ones my conscience does pain me because I do feel that I, as well as all our classmates should be willing to put forth a little extra effort to co-operate with you. You have done such an outstanding job of compiling the Class Notes for the *Review* that you certainly deserve the fullest cooperation and the heartfelt thanks of the entire class. Unfortunately I have no new, or interesting items to furnish you at this time. Since my knee was operated on, my activities have been greatly curtailed even though I am not entirely incapacitated. In fact I have been out of town only once during the past year and that was only a three-day visit to Pinehurst. I do have small, one-man manufacturing plant that is flourishing with very little attention from me except in case of emergency. Automation makes this possible. Occasionally I have to call in an expert to straighten out difficulties that arise when the conveyor system from the Production Dept. to the Shipping Dept. becomes overloaded and clogs up. I have plenty of competition as I do not have a patented product, nor a secret manufacturing process. There are many others in the same line of business so I make no claim to uniqueness. However, I am certain that the quality of my kidney stones compares very favorably with those produced by others. The letter from **Joe Barker** to **Van Bush** is excellent and truly expresses my sentiments. I guess I am too old-fashioned to fully understand the apparent student unrest. I reckon I was born 50 years too soon. I thank you for sending me the photograph of the group at the last gathering of the clan. It always gives me a kick to see so many familiar faces, but it does give me a jolt to think of the many that can never again attend a reunion. My copy of the *Review* just arrived and I am very sorry to learn that you were laid up. It was not clear whether this was repair, restoration, renovation or rejuvenation. In any case I hope you are again back to normal. I also see in the Class Notes that I am still playing golf. This bit of misinformation is completely without basis, in fact I haven't played golf for several years and even sold all my golf equipment three years ago." (Oops, sorry.)

In another letter to your secretary, **Bert Boulton** writes: "Sorry you have been laid up. You must be in shape for the holidays. A few days ago I had the privilege of attending a pretty select group of Alumni to hear from Ken Wadleigh and Ken Brock about the problems of M.I.T. While their news was not cheerful financially, they mentioned several items of great interest such as the much more intimate contact between the professors and students than is generally the case. We all agreed that the *Review* should emphasize such human items and less of the too technical articles. All of us were stimulated. I gave up my teaching a year ago but am much interested in my Red Cross work in which I have made dozens of toys for kids in our Head Start program here. Last summer my daughter and I had a most interesting trip thru Bavaria and Austria, enjoying the privilege of being house guests of four German families, and ending with three delightful days in Copenhagen. My son last spring passed his Ph.D. exams and is now completing his thesis. My oldest granddaughter married this year. It is interesting that my son, noted above, has adopted four children, multiracial, one being a Chinese and another Negro. What a change in attitudes! I am more convinced than ever that boredom is one of the greatest evils of the elderly. The remedy is to keep busy, especially doing worthwhile volunteer work."

Here's one from our Tennis Enthusiast cum laude **Jap Carr** to you: "Dear Len or Peb, which do you prefer? (Just 'do what comes naturally.') Yes, we are in delightful Palm Beach, enjoying beautiful bathing and tennis weather. Currently busy with painting the house, adding some air conditioners and the usual refurbishing that home owners go thru. It makes Hildegarde happy. We have not been anywhere or done anything so no travelogue from us. Have not seen any sixteeners but **Frank Ross** was here last week—another friend in the senior golf tournament said they were all so busy with golf, cocktails, etc. that no time for anything else. We have no jailings or known drug addictions or riotous conduct by children or grandchildren so maybe we are good parents or just lucky. In these confusing times it is difficult to be philosophical. After four and one half years I have still not been able to make indoor tennis at M.I.T. a reality. Still trying but the Institute is in such a financial bind and so troubled by a minority of students that other things are difficult to accomplish. Possibly by our 55th (not so far away) I'll get somewhere on this project. Am looking forward to seeing all good sixteeners next June."

We have another issue of *The Southwest News.* In the place for the price in the masthead it proclaims "No Cents." This four-page legal size publication is circulated now and then by Virginia and

Joel Connolly. The February 6 issue records among other items of interest, their cruise on the SAGA FJORD all around South America and through the Panama Canal, beginning and ending at Port Everglades, Fla. Fascinating. This issue will be available at our 55th reunion and is well worth a reading. A quote or two will indicate that the serious parts are well leavened. "Apparently defoliants were unknown in Adam's day, or other clothes would have been chosen." "She: Your wife is outspoken! He: By whom?" "A lady of our acquaintance wrote after visiting the Far East, of seeing a temple 'all covered with guilt'."

Rudy Gruber went off to Germany to be with his kinfolk over Christmas, and so missed the N.Y. 1916-17 Luncheon at the Chemists' Club on December 10. We always hope for some visiting 16ers on the first Thursday after the first Monday each month (September thru June) at the Chemists' Club, 52 East 41st St. Rudy was back for the January luncheon with **Jo Barker, Herb Mendelson, Walt Binger** and Ye Scribe. 1917 was represented by Dick Loengard, Clarence Seely and Bill Newberg. . . . Word comes from Gyps and **Cy Guething** in January at Delray Beach, Fla., where they hope to remain until the middle of March for sure "if the increase in Social Security comes through." Cy says they are toying with the idea of spending a week or more at a cottage in Dennisport following their little vacation at Chatham Bars Inn in June, following the 55th reunion. He had a nice long letter from **Gene Lucas** who is planning to be at the 55th. "We also had a nice note from Allie Jewett who will be near us at the Hillsboro Club. We hope to see her in February. She is a dream girl. She misses 'Moose' so much but has a nice family."

A letter from **Howard Hands** tells of a visit to **Dick Rowlett** who is in poor health in a nursing home in Clearwater. We all feel so sorry especially for Helen who has taken an apartment a block or so away to be near him. Howard also writes: "I finally got back to Boston last summer after five years' absence. But I didn't get very close to the old or newer M.I.T. I did whiz by on the new toll road, my old office building which was put up on the lot in back of the old Copley Plaza where we used to have the Technique Rush. Think of it—for 25 or 30 years I toiled in an office right over the spot where I got torn up and dirty from trying to get a free copy of that book so many years ago! There have been a lot of changes in that Back Bay area." . . . **Tred Hine** must be an old baseball player as he writes to the effect that "three times and he's out." This referring to his third retirement. His first was from the architectural firm of Smith, Hinchman and Gryllis; the second from Chrysler Corp. and now from the Detroit Institute of Arts. Tred joined up with the Institute for a six-months' project but it was ten years before they let him go. He was the first architect to be employed by them and now the job is terminated.

In case you missed it, here are extracts from a letter sent to classmates from our indefatigable Reunion Chairman **Bob O'Brien.** It'll be a great "gathering"—Don't miss it. "Here we are at another milestone—our 55th reunion—with memories of personal associations with classmates which reach back 60 years. Wonderful!

"Although some will not admit it and many don't show it, we are suspected of slowing down a little. For this reason, our reunion has been scheduled for mid-week thereby removing us from the weekend rat-race on the highways and airlines to and from the Cape.

"Chatham Bars Inn, which we have enjoyed on most of our annual reunions since 1953, is a beautiful spot. After 14 reunions there, our enthusiasm continues to grow for this seashore site, its comfortable facilities and warm, friendly service. Most of our accommodations will be in the cottages close to the main house. Usually, the weather has been ideal. Accommodations will be available both before and after the reunion for those who want to come early or stay late. The official reunion period will be from Tuesday afternoon, June 8, through Thursday afternoon, June 10.

"Attendance which has been great at our annual reunions and regular correspondence with classmates indicate that we should have a record attendance for our 55th Reunion. How well we recall the history-making attendance and the abundance of joy we experienced at our 50th!"—**Harold F. Dodge,** Secretary, 96 Briarcliff Rd., Mountain Lakes, N.J. 07046; **Leonard Stone,** Assistant Secretary, 34-16 85th St., Jackson Heights, N.Y. 11372

17

On February 25, the M.I.T. Club of Miami had as a dinner speaker, Brian Strong '63, who demonstrated I.B.M.'s "Suit Case Terminal." Resembling a flattened typewriter, the terminal was connected to a downtown computer simply by dialing the correct number, then putting the receiver on its resting place in the terminal. Beeps transmitted the signals from the typewriter-like keys to the computer, and beeps from the computer sent back response messages typed out with great rapidity on the 18-inch wide roll of paper. The possibilities of the small terminal for use in the home, by traveling salesmen, in offices, etc., seemed limited only by one's imagination. To demonstrate operation, the code word calling for "Black Jack" programming was given, and guests played the machine as dealer. Star player was an eleven-year-old boy called Josh, who more than doubled the paper stake of $500 in his stretch at the game with the computer. Oh—Josh is the youngest son of one **Joseph Littlefield,** who is active in the Miami M.I.T. Club, and who also had with him other guests and friends, including his wife Doris, Betty and **Ken Lane** and **Ray Stevens.**

Betty Lane has had **Jim Flaherty**'s Gloucester watercolor placed in a frame that brings out its color and character, and it now hangs in the Lanes' Florida living room. Ken has no regrets for having won the auction for it at Northfield. He still plays golf several times a week and now has a sizable powerboat. He boats and fishes with it and once or twice a month spends a day or two for the Coast Guard, in its Volunteer Auxiliary, patrolling the coastal waters. He recently reached a fifty-four-foot boat aground in distress and was able to pull it out to operational depth without calling in larger craft. With these distractions and with his son Bob's family within reach he has not time to get bored or become inactive. . . . The above was contributed by our star reporter, **Ray Stevens.** Ray wrote our class notes for too many years as Class Secretary not to appreciate a news story and also to know how grateful a secretary is for the help. . . . Your secretary has also had his Jim Flaherty watercolor of the "Big Sail" on the M.I.T. Campus framed, and enjoys it greatly.

How young aviation really is was brought to mind when **Les Ford** got to telling of the early days at McCook Field, Dayton, with Ken Lane and Ed Beldon. Les visited often with Orville Wright in his laboratory. . . . **Al Lunn** returned from his ninth Mexican Fiesta, enthusiastic over the well-attended, well-run affair where the Killians were the guests of honor. Some 80 alumni and guests from north of the border were there. 1917 was well represented by Conchita Lobdell Pearson, the Killians, the Dennens, Ray Brooks and Al. It was the third Fiesta for Ray and the 15th for the Dennens (habit forming). Bill Dennen's hip operation of last fall was successful enough so that he drove from Pennsylvania to California to Mexico City and then drove home in easy stages. Their son, William H., Class of '42 has been made acting dean of the Graduate School, University of Kentucky and serves on several administration committees also.

Dud Bell came to Peter Bent Brigham Hospital, Boston for consultation on his ailing leg. He went home hopeful of improvement. . . . The March lion held attendance at the '16-'17 Chemists' Club luncheon to three '16ers and **Clarence Seely** and **Dick Loengard** for '17. . . . We have some address changes: **Hartley B. Gardner** to 49 Amherst St., Auburn, Me. 04210 and **Samuel L. Kuhn** to 23 East 74th St., New York, N.Y. 10021.—**Stanley C. Dunning,** Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard,** Assistant Secretary, 21 East 87th St., New York, N.Y. 10028

18

Several months ago, I wrote you about the corridors at M.I.T., how they changed from being bare to becoming the resting

place of notices, many of them scribbled on the walls, some in poor taste and plainly devoid of any artistic content. Last fall I reported a great improvement with a more orderly arrangement of material though still inclined to be occasionally bizarre. A few days ago I traversed these halls again and much progress has been achieved. I recommend you visit and see the illustrations of stroboscopic effects, the mural depicting the urban problems of decay and the high quality of other decorations. I think you will agree with me that the students and administration are to be commended on their fine accomplishments in this area.

In these days of indifference to family relationships, I am heartened by your correspondence which, in simple and direct ways, reflects the love between us 1918ers and our wives. In the enclosure from **George Oxley** is a reference to the death last year of his team-mate. Such tender thoughts have come from most of you who have experienced this great loss. George recalls in this letter in particular the photo of the 50th reunion and his many contacts with classmates and professors over the years. He is active in the Northern New Jersey M.I.T. Alumni Chapter. His business career has been with Esso, working on layouts for new refineries, pressure still safety, inspection and increased life of structures, among other duties. Particular stress was given to problems of corrosion, tank coatings, paints and inhibitors. Publications included articles in the *Oil and Gas Journal,* among others. During World War II, he did special work for the National Defense Research Corrosion Council. Other assignments included teaching in the evening at Rutgers University as well as at Brooklyn Polytechnical Institute and N.Y.U. In addition, there were problems to be researched because of tanker collisions. In 1919 George married Alice Brown, with whom he celebrated his 50th wedding anniversary two years ago. After his retirement they travelled extensively for pleasure. During his business career he visited many locations in this continent and South America. He is a member of the Sea Horse Institute, in connection with research in North Carolina on salt water corrosion, as well as the National Association of Corrosion Engineers. He is a director emeritus of the Brooklyn Polytechnical Institute, of which he is an alumnus.

The above news was inspired by a letter from **Len Levine** to George. Another letter in response to his appeal for news is reproduced here: "Dear Len: I remember you perfectly at M.I.T. in 1917-18. I left school on December 15, 1917 with the understanding that if I joined the Army I would get my degree in June 1918. I got permission to enlist in the Ordnance Corps. in Watervliet Arsenal and I was assured of three squares for some time to come. I got a shave-tail commission in July 1918 and went overseas with an ordnance battalion in September. We were assigned to the Mehun workshops in the geographical center of France and I was in charge of a repair unit there. I got a first lieutenant's commission in winter of 1919 and brought my company home in July 1919. Went to work for the Saco Lowell Shops in September and married a Somerville girl in October. Kicked around in a couple of shops after that and started my own machine shop in 1920. Did a lot of work for people like Simons Saw Co. in Fitchburg and did pretty well when the Second World War broke out. After the war I got a job as an instructor in machine drawing and descriptive geometry in the University of Miami in Coral Gables. After 5 years of this I was retired and came back to Fitchburg. Sold out my Fitchburg holdings and retired to a cottage on Lake Menomock in Rindge. Lost my wife after 50 years and eight months and this was a big blow. Have two grandchildren, a boy and a girl. Their mother died when she was 30. I will be 80 this April and, according to Alex Magoon, I was the oldest one in our class. I read and work in a garden in the summer. Have a nice housekeeper. I feel pretty well but have to take medication to keep my blood pressure within bounds. If you are up this way, look me up." Signed, **Ben Ballentine.**

A third letter courtesy of Len Levine follows. **Donald C. Goss** writes: "Dear Len: Y'see, I can't type either, but will take a whack at it and see if I can come up with anything worth looking at. Staggering statistics: Born, they tell me, July 19, 1894, Lynn, Mass. Usual procedure through public schools and entered M.I.T. from Lynn Classical High in 1914. Took, Godhelpme, architecture and had my B.S. mailed to me in September 1918. Left school for service in March 1918. O.C.S. in field artillery, Louisville, Ky., then to Texas, Camp Stanley near San Anton'. Discharged December 1918 and back home looking for a job. No combat, no medals, no money.

"First job with Cram and Furguson, then Guy Lowell until 1930 when (remember?) the depression hit us all and back to the pavements for a few months. Opened own office (in desperation) in 1931 and have been at it ever since. Serve coffee every morning at 10:30, visitors welcome. So much for professional.

"Now the family, of whom I am inordinately proud: married Ruth Johnson, February 1920. Four children: Virginia, who is teaching first grade at the Tower School, Marblehead; Davis, who heads up 'Ideation' a firm which finds a better way to do things; Richard, a professor of biology at Brown University; and Nancy, an R.N., but now a wife and mother of three in Wisconsin. Eleven grandchildren, all counted, and almost everybody calls me 'Grampa', seems like. Aside from a couple of operations, my health has been excellent. No complaints. So you see it is pretty dull doin's, reading-wise. I've had a lot of fun out of life and hope for a lot more. A big high to all the gang. Don Goss. P.S. Yes, Max has been after me, but your note 'broke thru'!"

And again, Len is responsible for this short note from **George Halfacre:** "Dear Leonard: Remember you. Indeed I do. Thanks for your letter and an excellent try to get me to be newsy. There is nothing newsworthy about me—so 'excuse please'. Well and active, retired of course. Between travel and a large family we find life interesting despite all the frustrations of the current era. Again thanks for your kind letter."

Bill Foster sent me a page from the Fall 1970 issue of the *Gear* of Theta Tau in memoriam of Past Grand Regent (1927-1929) **J. Sidney Marine,** as follows: "J. Sidney Marine, Past Grand Regent of Theta Tau, passed on at his home in Scarsdale, N.Y., May 13, 1969. Brother Marine served Theta Tau as Grand Vice Regent from 1921 to 1925, and then as the third Grand Regent of the Fraternity from 1925 to 1927. He was elected Grand Regent at the Seventh Biennial Convention, at Columbus, Ohio, at a time when, except for those attending from Sigma Chapter at Ohio State, all eighteen delegates and five national officers traveled by train to the convention. Also, at this time, there were about 3,000 Theta Tau initiates and Brother Marine . . . knew a very large proportion of these members. Until the time of his death, he continued his work of teaching which he loved."

This article also offered excerpts from another tribute appearing the May 22 *Scarsdale Inquirer* which recognized J. Sidney Marine's special contributions to the civic life of the Scarsdale community: "Graduate of M.I.T., veteran of the Air Force and World War I, Sid discovered an aptitude for teaching in the bleak days of the 1930s. For three decades as a private tutor he worked with the underachievers . . . By his skill and his warm personality he rescued many a confused youngster from academic failure and sent him on his way to a better relationship with his family, a better chance for success in college, a better prospect of mature and responsible adulthood."

Incidentally, I noted an editorial reference recently in the *Christian Science Monitor* quoting our **Bill Foster,** with his background as former head of the Arms Control and Disarmament Agency, who believes it is now possible and safe for both Moscow and Washington "to ban all testing, not just atmospheric testing, but all testing, including underground." How would this action control the nuclear race if it were accepted? Bill's answer: "Do this and you automatically slow down and ultimately end nuclear innovations, for you remove the means of development. To end all nuclear testing is like taking the test tube away from the chemist. This one, logical, sensible step would answer all the bothersome points now taking us endless hours of fussy negotiations in SALT."

It is with sadness that I conclude with a letter from Gerald, son of **Harry L. Katz.** "It is with sadness that I write to tell you of the death of my father, Harry L. Katz, who passed away on January 14, 1971, following a short illness. He was 78 years old and had lived in Baltimore since 1920. My father was born in Malden, Mass.; he attended Mechanics Arts High School in Boston. He was graduated from Harvard University Class of 1915, M.I.T. Class of 1918. While at M.I.T. he also received a certificate in naval architecture and marine engineering and worked briefly at the Boston Navy Yard as inspector of naval construction. After World War I he came to Baltimore to continue work in ship construction. For the past 45 years he had worked in private practice as an architect and engineer in the Mid-Atlantic area. He was a member of the Society of Professional Engineers and had served as its president in Baltimore. My father retired from his architectural and engineering business in 1968. Sincerely Gerald I. Katz." Harry was one of our most loyal classmates, and always made a special effort to join us at all our reunions—even when his health picture discouraged such a trip. Our sympathy is extended to his family. We shall miss him.

As you see, Len Levine is responsible for the news of this issue. I am grateful to him. Why don't some of you do what he did—write to a dozen or more classmates whom you have not seen or heard from for a half century. If you need current addresses write to me.—**Max Seltzer,** Secretary, 60 Longwood Ave., Brookline, Mass. 02146

19

Mary and **Arklay Richards** drove up from Pompano Beach on Saturday March 13 and had dinner with us at the Patio in Delray Beach. Ark and Mary vacation at Silver Thatch Inn and play a great deal of tennis there. Ark has seen **Bob Bolan** at Sarasota. Ark's business—Arklay S. Richards Co. Inc., Newton Highlands, Mass.—has been growing and expanding and still occupies some of his time. They manufacture thermocouples and related equipment.

W. Roy Mackay now resides at 1310 Magnolia Ave., Winter Park, Fla. 32789 and Captain **Edward E. Saunders** at 13117 Greenmount Ave., Beltsville, Md. 20705.

Helen and **Ed Moody** sent an invitation to any classmates touring through the White Mountains this summer to stop off at their home 29 Hazel St., R.F.D. #3, Nashua, N.H. 03060 (Tel. 603 889-4297) The Moodys both were in the local hospital last fall but are now in high speed again. Ed will be in Kentucky helping teach dancing at Morehead State University August 8 to 14, 1971.

Your secretary has been playing lots of golf here at the Delray Beach Golf and Country Club, the Delray Dunes Golf and Country Club and the National P.G.A. Golf Club at Palm Beach Gardens. We will be heading north in June for 4½ months. We had our seventh grandchild, Rebecca Louise Hodgkin in Baltimore, February 8, 1971. Best wishes for a good summer and please send some news in for this column.—**E. R. Smoley,** Secretary, 50 East Rd., Apt. 11E, Delray Beach, Fla. 33444 Tel. 305 278-4537

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We haven't heard from **Arthur Hartsook** for quite some time but have received word that he hangs out at 3122 Stanton, Houston, Texas. Arthur has been professor of chemical engineering at Rice Institute in Houston.

A card from Florence and **Lee Thomas** postmarked Kowloon, Hong Kong, contains the news that they have been spending a month in the Orient with some Chinese friends from Malaysia. Lee observes that although the Chinese control the economy of Malaysia they are a minority and are subject to discrimination, a fact familiar to me because I just finished reading Dennis Bloodworth's interesting and up-to-date book on Indonesia, *Eye of the Dragon.*

At this writing, the Class remains in deep hibernation, the result, no doubt, of the long, tough winter, although the fact that the large number, perhaps even the majority, of classmates are basking in the sunshine of Florida would seem to refute that surmise. Your secretary passed up Florida in favor of California, just north of the Golden Gate, where he and Amy participated in the ceremony of induction to Eagle Scouts of their grandson, David.

Now that spring has at last arrived, let us hope that the rising temperature will loosen the flow of communication like sap from the maples.—**Harold Bugbee,** Secretary, 21 Everell Road, Winchester, Mass. 01890

21

This is it! Last call for the "Reunion Redcoat Roundup" of the Class of '21 on June 3 through 7, combining our 50th Reunion jubilee with the M.I.T. Homecoming '71 events. You had better take steps right away to make reservations if you and your wife want to find this year's most pleasurable and unusually fine vacation. Come see your buddies of olden days and partake of the many amazing features of the program which Reunion Chairman **George A. Chutter** has conjured up for the sheer enjoyment of all the men and women in attendance. Come find out how much more joy the annual Homecoming party offers in conjunction with our Golden Anniversary Celebration.

You'll get to meet with the Institute's President-Designate, Dr. Jerome B. Wiesner, and to welcome him as a member of the Class of '21; Dr. Paul E. Gray, '54, the newly-designated Chancellor of M.I.T.; Chairman of the Corporation Dr. James R. Killian, '26, who closes an outstanding career in active administration of the Institute at the end of June, and our distinguished classmate, President **Howard W. Johnson,** who has been named to the top post as Chairman of the Corporation. From your participation in cap and gown at Commencement, through luncheons, dinners, a shore clambake and a golf tournament to Tech Night at the Pops with Arthur Fiedler and the full day of Homecoming events, you won't find better entertainment or as much fun anywhere else.

Phone George for your 50th Reunion reservations at 617 385-3126. His address is at the end of these notes. To get in under the wire, also phone the M.I.T. Alumni Association, 617 864-6900, Extension 4878, for tickets to the Homecoming program. Please act at once so you won't miss any part of the biggest event in Class history—one that will never come our way again. Join '21 in 'Seventy-one!

Icing for the Cakes

For his brother Hexalphas in particular, it will be of interest to learn that **Harold H. Cake,** 5046 S.W. Hilltop Lane, Portland, Ore. 97221, is an antique car buff whose prize possessions include a 1909 Cadillac "gentleman's roadster" with a "mother-in-law seat," a 12-cylinder 1933 Pierce Arrow which once belonged to his father, a 1926 Model T and a 1947 Lincoln Continental. Cookie is active in the Horseless Carriage Club, the Historical Automobile Club, the Pierce Arrow Society and the Lincoln Continental Club. He has written Class Vice President **Irving D. Jakobson** that he will retire in July as chairman of Equitable Savings and Loan Association with which he has been associated since 1946 as director, vice president and president. He has a married daughter and two grandchildren.

Larcom Randall, Apt. 52, 5860 Midnight Pass Rd., Sarasota, Fla. 33581, writes that this is his official residence and that he and Katharine still spend summers in their cottage on Lake Winnipesaukee, N.H. In sending greetings to the Class, he says, "We are surrounded by M.I.T. men here on Siesta Key—mostly younger—but we do have a sense of camaraderie which does not recognize age differences." Larc retired in 1958 as head of Larcom Randall Advertising, Inc., Boston industrial advertising firm and still keeps active in the industrial-scientific-technical advertising field.

Harry Butters, 44 Washington St., Brookline, Mass. 02146, sends a most encouraging and pleasantly surprising report: "It's great to be healthy and enjoying the wonders of this age. I'm still spry enough to do passable somersaults and back flips, and enjoy skating." Harry heads his own insurance firm at 153 Milk St., Boston 02109, and is a

Roy A. Wehe, '21

director of Butters Manufacturing Co. He has two married daughters and two grandchildren.

Flying for 50 years

"I completed 50 years of flying in 1968, having attended the Army Aviation School at M.I.T. in 1917 and qualified to fly single-seat fighters in France in 1918. Turned down a job flying air mail in 1920 and then resumed flying on a pleasure basis. Flew some rented planes and had two of my own. Visited throughout the U.S. and Canada with my own four-passenger plane, purchased in 1946. Have traveled a lot on business and for pleasure and still have hopes to make it around the world. No longer agree to join in any game you name, but still enjoy contract bridge." These are the words of **Percival B. Crocker,** 41 Granite St., Foxboro, Mass. 02035, board chairman, director, treasurer and trustee of the Sentry Co., Foxboro, with whom he has been associated since 1926 in various technical and managerial capacities. Active as director and officer of numerous industrial, civic, philanthropic and social organizations, he also maintains membership in several professional societies. He has three married children and 11 grandchildren.

Arthur A. Turner, 686 S.W. 4th St., Boca Raton, Fla. 33432, says, **"John W. Shepard** phoned me from his new home in Boca Raton a couple of miles away and I hope to get together with him. Madelyn and I had been planning to attend the 50th Reunion but my oldest grandson's baccalaureate and commencement from high school in Toledo, Ohio, conflicts and we can't let him down." Art retired in 1966 as vice president and general manager of the refractories and electronic division and vice president of the International division of the Carborundum Co., Niagara Falls, N.Y. The Turners have a married daughter and three grandchildren.

Helen and Class Estate Secretary **Edmund G. Farrand,** 5981 La Jolla Mesa Drive, La Jolla, Calif. 92037, have been planning a meeting in the spring for the dozen members of the Class who reside near them.

Pre-Reunion reunions

From Hollywood, Fla., where he had just received the National Community Service Award, **Saul M. Silverstein,** chairman of the Rogers Corp., Rogers, Conn. 06263, reports having attended a mini-reunion in Miami Beach as the guest of Roslyn and **Louis Mandel,** Seacoast Towers, 5151 Collins Ave., Miami Beach 33140 and East Orange, N.J. Others of the Class present were the **Harry Goodmans**, the **George Schnitzlers** and the **Edward I. Mandells**. Saul sent regards from the group and added that all are planning to be in Cambridge in June.

Writing from a vacation spot in Palm Desert, Calif., **Roy A. Wehe,** consulting engineer, 660 Market St., San Francisco, Calif. 94104, has told Irv Jakobson and your Secretary of a delightful gathering which he and Grace had with Peggy and **Eugene W. Rudow** and Katherine and Horace W. McCurdy, '22, who were vacationing nearby. Roy also says: "Irene and **George T. Welch** of Poughkeepsie, N.Y., stopped off on their drive from New York to visit a married daughter in Menlo Park, near where we live at 51 El Cerrito Ave., San Mateo, Calif. 94402. They want us to come back for the Reunion." Regarding the "quake" Roy says, "Outside of the news, it might never have occurred so far as Grace and I were involved. We had left San Mateo that morning to drive down the coast route toward Los Angeles, so had no trouble. We were at our married daughter's home in Palos Verdes that evening and in Long Beach the next day. The shake was felt in both sections, but no damage."

Betty and Assistant Secretary **Sumner Hayward,** back home in Ridgewood, N.J., from their vacation in Sarasota, Fla., have provided pictorial evidence of one of their gatherings with Florida classmates Claudia and **Josh Crosby, Tom Dutton,** the **Larc Randalls**, and the **Dick Spitz** and **Ted Spitz** couples. The Haywards report a number of enjoyable meetings with individual pairs of this group and a fishing trip with Millie and **Herb Kaufmann.** Sumner's brother, Cary, and his wife are long-time friends and now near neighbors of Henrietta and **Carl W. Hammond** 1107 Mariposa St., Vallejo, Calif. 94590. Carl is the retired safety engineer of the Mare Island Naval Shipyard.

Your welcome letters

From their winter home at 8894 112th St. N., Seminole, Fla. 33540, Becky and **Elmer W. Campbell** say they will return to their summer quarters, Lovell, Maine 04051, in time to attend the Reunion. . . . **Joseph Wenick,** 37 Cedars Rd., Caldwell, N.J. 07006, is co-chairman of the four six-hour sessions on "Business Management and Professional Development" included in the spring series of seminars for alumni sponsored by the M.I.T. Alumni Center of New York. Sumner Hayward advises that Joe has fully recovered from recent illness. . . . Ruth and **Irving D. Jakobson,** Northfield

Members of the Class of '21 in Florida. From left to right: Mrs. S. Hayward, J. D. Crosby, Mrs. T. P. Spitz, L. Randall, T. P. Spitz, R. J. Spitz, T. D. Dutton, Mrs. J. D. Crosby.

Rd., Glen Cove, N.Y. 11542, sent a photo of Paradise Beach, Paradise Island, Bahamas, with the notation: "We are doing some sailing in the Bahama Islands and are now in Nassau." At this writing, Maxine and your Secretary are looking forward to their promised visit to us in Brielle.

John W. Shepard reports from his winter home, 2408 Maya Palm Drive East, Boca Raton, Fla. 33432, that he recently talked with the other three Boca Raton residents who are members of the Class: **Scripps Booth, Larry Castonguay** and **Art Turner.** John retired in 1965 as manager of the industrial engineering department of the Walworth Co., South Boston, Mass. He and Elise maintain their permanent residence at 9 Day St., North Easton, Mass. 02356, and spend their summers at 177 River St., Bass River, South Yarmouth, Mass. 02664. Daughters Elise and Mary both attended Wellesley. The Shepards have two grandchildren. . . . **David O. Woodbury** penned one of the shortest messages on record: "So far have stayed home all winter with the flu. Have managed to work steadily on my fourth novel and to put out two magazine columns a month, one on science and one humor." Dave and India live on Shore Rd., Ogunquit, Maine.

Class Agent reports

The recent letter and Amity Fund data you received from Class Agent **Edouard N. Dubé**—on which we hope you already have taken action as Ed suggested—is a notable tribute to all of the Class who have so generously responded to the efforts which Ed, Irv Jakobson, Chairman of our 50-Year Gift to M.I.T., and Ed Farrand, Class Agent and Estate Secretary, have contributed toward assuring the Institute's continued technological leadership. In letters and phone calls, Ed Dubé has expressed his own concern over the erosion in endowment income caused by inflation, the restrictions on research funds resulting from government policies and the lowered national economy, and the necessity for far greater amounts than can result from the Institute's sharply increased tuition charges.

We hope that everyone will be moved to act on Ed's special appeal to swell our Class giving at a time when the real needs of M.I.T. surmount our provincial desire for prestige in the size of our gift. It is most encouraging to note from the figures that the February status of our giving is the second largest in dollar amount of the 94 class and course units reporting. May your unstinting support increase it to first place in this time of crisis! We are pleased to report that Ed is making good progress to recovery from his serious auto accident and we are looking forward to a coming visit with him and Maida to add to the good wishes which many of the Class have sent him.

Madeline and **Ralph M. Shaw, Jr.,** sent greetings from Sanibel, Fla., during the return trip to their Beverly, N.J., home from a vacation in Barbados and the Virgin Islands. Rufe says they met with Milena and **Roderick K. Eskew** in Sanibel and convinced them to attend the Reunion! . . . **Edwin F. Delany,** 8 Welgate Circle, Wollaston, Mass. 02170, says, "After our return from Europe, Kay went back to the hospital for a major operation—her fourth. Now doing nicely but recovery is slow. We are staying in the north this winter." . . . With aloha to all of the Class, Catharine and **Harry P. Field** write, "We regret that we will very likely have to miss our respective 50th reunions at M.I.T. and Smith due to Harry's poor health. We had talked of and planned on going and it is a big disappointment. We are sure it will be the best ever and we will look forward to hearing all about it." The Fields live in the Arcadia Apts., 1434 Panahou St., Honolulu, Hawaii 96822.

Eddie and **George F. Gokey, Jr.,** 98 Westminster Dr., Jamestown, N.Y. 14701, have written several times of their enthusiastic anticipation of the 50th Reunion. Most recently they sent a view of "Pasanggrahan," the guest house where they spend the winter in St. Maarten, Netherlands Antilles. They call the spot "Instant Summer!" . . . Speaking of photographs, we received a gorgeous one from **Laurence O. Buckner,** 2630 Durham Rd., York, Pa. 17402. Taken last year when he and Mary were in Elizabeth City, N.C., it shows the partial eclipse of the sun, with the moon precisely centered and a considerable darkening of the countryside.

Allen D. Addicks, Apt. 612, 1868 Shore Drive, South Pasadena, Fla. 33707, writes, "I am taking a course in astronomy at the local college and digging in Indian mounds as a member of the archeology society. Patty fell and broke her hip which spoiled plans for the year-end holidays. She hopes to be walking by reunion time. . . . Emma and **Leon A. Lloyd,** 35 Spruce St. Westerly, R.I. 02891, had a monumental celebration of their 40th anniversary last year with their three children, seven grandchildren and 70 guests. Al is serving on George Chutter's Reunion Committee; Emma continues her hospital volunteer work.

Join '21 in 'Seventy-one!
Please bring your wife and come back to Tech for our 50th Reunion! We all want to see you again and we know you will both have the time of your lives in the cordial group that will be present. We hope you have contacted your closest friends to urge them to join you on this unique occasion. But whether or not you recall the classmates who do attend, you can be sure you will be right at home within the group to enjoy an occasion that comes but once—if at all—in the lives of college men. This is our final opportunity to beg you to reconsider a negative decision and to take immediate steps to "Join '21 in 'Seventy-one!"

Write or phone any of those listed below for whatever assistance we can give—NOW! And when you do, please don't forget to remove the last page from the Class Directory you received, fill in the information requested and mail it to us at once. This is the best way you can help us to help you. Here's to seeing you next month in Cambridge!—**Carole A. Clarke,** Secretary, 608 Union Lane, Brielle, N.J. 08730; **Edwin T. Steffian,** Assistant Secretary, Steffian, Steffian and Bradley, Inc., 19 Temple Place, Boston, Mass. 02111; **Sumner Hayward,** Assistant Secretary, 224 Richards Road, Ridgewood, N.J. 07450; **George A. Chutter,** 50th Reunion Chairman, Box 305, Boulder Drive, East Dennis, Mass. 02641

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The **Dale Spoors** sent a beautiful picture postcard of Table Mountain and Capetown. We were there last year at this same time and fully appreciate their enthusiasm for this beautiful part of the world. Dale and Katherine are following the sun on their 90 day round-the-world cruise on the *Rotterdam.* We hope they will bring us presents from Hong Kong and Bangkok. At the moment of this writing they are on safari to Victoria Falls and Kruger Park. We will hear all about it and see the pictures at our June 7 reunion. . . . **Frank Kurtz** reports that **Yard Chittick** and **Bob Tonon** visited him during January. Frank is still playing bridge and tennis, and with Carlys is interested in theatre work at the Del Ray Beach Playhouse. At times he teaches conversational Spanish also. They will both be performing on the stage in March in *My Fair Lady* so that we will get a report from the other side of the footlights and readings of the applause meter.

Your secretary is now winging his way to Central America and his Girl Friday will try to keep the Class of '22 posted. Today we received the first scenic postcard. While we struggle through March storms, interspersed with bright sun and wind, he is absorbing tropical scenery and enjoying life beneath the palm trees. . . . Our congratulations to Dr. Jerome B. Wiesner upon his election to the presidency of M.I.T. President-elect Wiesner, a specialist in communications science and engineering with a B.S., M.S., and Ph.D., in electrical engineering, will be our 13th president. He has been associated with the Institute since his return in 1946 from the California Los Alamos Radiation Laboratory. The Institute is fortunate to have this brilliant and dedicated scholar for a leader. . . . We are especially proud of our new Chancellor, Paul E. Gray, the Class of 1922 Professor. Dr. Gray is a skilled and gifted teacher and his recognition is well deserved. He received his S.B., S.M., and Sc.D. degrees from M.I.T. and has been a member of the teaching staff in electrical engineering since 1957. He is ideally suited to his new position because of his work in undergraduate curriculum development and as Chairman of the Freshman Advisory Council as well as Associate Dean of Student Affairs.

Paul Keyser sent a communication requesting briefer Class Notes for the *Review.* This, of course, is due to the problems besetting activities everywhere, so your secretary's secretary will do her best to make this particular report brief as well as newsworthy, and hopes it meets with the approval of the man-at-the-helm when he returns the end of March. . . . Schedules being what they are, the Fergusons will be in Mexico City on March 15-17, just missing **Parke Appel** and his family. However, they will be at the Acapulco-Hilton about the same time the Appels will be at the La Pesca and will probably manage a satisfying get-together.

The sympathy of our class is extended to the family of **Domnal F. Kelly,** of Lanesboro, Mass. who passed away November 26, 1970.

Your secretary will have much to tell you and pictures to exhibit at the June reunion. He expects to visit the ruins of Copan, the Mayan civilization dating back to the early days of the Christian Era, and the ruins at Antiqua plus beautiful Lake Atitlan. To this wonderful trip back through ancient history he will add the exploration of the temples, shrines and palaces of the ancient city of Chichen Itza. I am sure when he dictates his June notes for the *Review,* his secretary, as she has done before, will be so interseted, she will forget to take the notes. Let us hope, however that he doesn't decide to dive off the rocks into the sea at Acapulco. At least not until Parke Appel is there to join him. As your secretary would conclude his monthly notes: Good Health, Good Luck to you all and a safe return to the travelers.—**Whitworth Ferguson,** Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz,** Assistant Secretary, 45 Gerard St., Boston, Mass. 02119

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In regard to our recent election of class officers, the results were as follows:

Total votes cast—183. *Ballot question 1:* To elect 3 vice presidents until the 50th Reunion. Yes—158, Not voting—24; *Ballot Question 2:* First Vice President—**Edwin C. Schmitz** of Clearwater, Fla.; Second Vice President—**Charles M. Mapes** of Suffern, N.Y.; Third Vice President—**Rodney C. Goetchius** of Vero Beach, Fla. Yes—179, Not voting—3; Other Candidate—1 (**Norman Weiss** for all three jobs!). As you will recall, the dateline for the return of all ballots was March 1, 1971.

Our very busy **Thomas E. Rounds** has been elected vice president of Rotary beginning next July for one year, and then president for 1972-1973, if, as he says "they don't throw me out for bad behavior." (No comment, Tom, but best of luck and congratulations.) . . . I am advised that **Herb Hayden** has reserved the Marriott Motel on Route 128 for our 50th Reunion in June, 1973.

Julian E. Berla reports that he has been retired from the Washington Firm of Berla and Abel after having been in practice for more than 45 years, but will continue as an architectural consultant.

Luis R. de Luzuriaga is a technical director for James Ryan and Son in New York. He works in the field of domestic and international finance and investment. (Do you need advice in this direction?) . . . **Arthur L. Hill** states that his first year of retirement has been a busy one with side trips to Hawaii and the East Coast. He lived in Denver, was married last September to Mrs. Maria von Kurz, and they are now living in San Diego, Calif. . . . **Michael Drazen** is still active as consultant to industry on electric and gas rates, contracts and business problems. He has two sons at M.I.T., Mark involved in a thesis for his master's, and Allan, a junior in economics.

Charles M. Mapes was retired from A.T. and T. in 1966, and has organized a communications consulting firm, Complan Associates, Inc. This keeps him busy and he is true to his motto, "Better to wear out than to rust out." . . . **Clarence J. Odell** was retired from Babcock and Wilcox on June 1, 1966 and is apparently living in Florida. . . . **Chaplan Tyler** is consultant for the Coca-Cola Company and finds that exposure to their innovative attitudes is a refreshing experience. . . . **Bill Glendinning** reports that he has been very active in professional engineering over the past 25 years. He has also assisted young engineers to prepare for license examinations and has taught such subjects as structural planning, basic engineering science, civil engineering, and electrical and mechanical engineering. He has also written pamphlets on these subjects. His life work will be more fully described in our forthcoming class history.

Scott V. E. Taylor lives at Canoga Park, Calif. He states that the recent earthquake broke a few lamps and antique vases but caused no real damage. Houses in his area have concrete floors to withstand shock. His house is about eight miles from the area below the Van Norman Dam, which was evacuated.

William S. LaLonde, Jr., reports that this is his fifth year with Edwards and Kelsey, Engineers and Consultants of Newark, N.J., and also his fifth year as treasurer of A.S.C.E. He and Marion were in Bermuda last fall, and are planning a trip next summer to Alaska, all the way north to Barrows.

It is with regret that we report the passing of **Richard D. Ferguson** on December 6, 1968 and **George H. Ludlow** on January 19, 1971.

That's All Folks!—**James A. Pennypacker,** Assistant Secretary, Long Hill Rd., Essex, Conn. 06426

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Upon assuming the scribe's mantle for the class, I was handed a list of classmates who do, and, who do not receive the *Review*. Ver-r-ry inter-r-resting!—256 do and 356 do not. A call to **Frank Shaw,** Class Agent, confirmed my suspicion that recipients were also Alumni Fund supporters. Our sincere thanks to each of you! My next conjecture spawned the question: "Just what sort of information should I feed this erudite group?" Please let me know. For instance, **Maynard L.** (Lank) **Harris,** as a saddle horse owner for 25 years, took exception to his registered horse being called a "plug." Apparently this hurt more than his injuries. . . . **Witter T.** (Doc) **Cook** says that he has retired to the kinder climate of Florida's West Coast after 40 years with General Electric, largely in staging major business and shareowner meetings. Just shows that the Institute sidelines of "Voo Doo," Tech Show and Masque can back-seat electrical engineering.

In the same mail, **Gilbert H.** (Gib) **Cowan** confirms Herb Stewart's telethon call of last November that he and Nancy were visiting Rome, Dubrovnik, Sicily, Malta and Tripoli. This seems to be in the nature of a celebration following a very close call in Chicago, due to a ruptured aorta aneurysm, which a highly skilled surgeon corrected. It appears that Cowan's Department Store in Sault Ste. Marie, Mich. is the local source for maxies and minies. . . . Our sympathy to **Henry Rau** upon the loss of his wife after a long illness. He finds comfort in his two daughters and four grandchildren. Henry commutes from Alexander to his electronics business in Washington.

Paul Cardinal and Lorene on February 26 began a safari through Florida. After resting in Siesta Key, Sarasota, they set out to hunt Homo sapiens in the form of **Si Duevel, Paul Miller, Gordon Harvey** and **Clint Conway.** If that does not wear them out, they will stop in Cincinnati and arrive at the lair in New Jersey about April 1st. . . . Although **Everett E. Elting** did not graduate with us, he has retained his interest in M.I.T. and is now connected with Paul's avocation, International Executive Service Corps, and will be on assignment in Peru during March, April and May.

We were sorry to learn of the passing last August of another loyal non-graduate, **James J. Hairston.** He had been with Western Electric in Winston-Salem.

Notice has been received that **Herbert H. (Fritz) Engemann** died October 16, 1970. Not much is know" of his career, although he came from Waverly, Mass. and prepared at Utah Agricultural College.

From New Canaan, Conn., **Dave Evans** reiterates how much we all loved Chick Kane and will miss him. He has suggested some action in memoriam, possibly in the form of a publication compiling Chick's handiwork. Dave is retired, but is happy, as a librarian for the New Canaan Historical Society. He tells us that **B. Alden** (Cush) **Cushman,** Darien, Conn., spends four days weekly with the Union Trust. They and their wives represented '24 at the Darien-Fairfield County dinner honoring President Johnson and had a long chat with him.

Having only a lukewarm confidence in our news media, I sought an "on the spot" view of the California 'quake from **Bill MacCallum** and he obliged. "As usual the reports of the earthquake in the eastern papers were exaggerated. We had a really major 'quake in a previously quiet fault north of the San Fernando Valley. The mountains caused the force to focus on the area of the Veterans Hospital and the Olive View Sanitarium, destroying both with considerable loss of life. In this whole area there was extensive structural damage to houses and other buildings, but few people were hurt. The new high-rise buildings stood up in fine shape. There was plaster damage and some scrambling of contents but nothing really serious—just expensive. We came off very well. Our 18th floor apartment shook violently and creaked like a ship in heavy sea. We only have a few fine plaster cracks not worth fixing. Some cupboard doors were opened and a couple of our M.I.T. plates were ready to fall! Just luck, I guess. **Phil Bates'** and Jocky's main oddity was that the water in their small patio pool all sloshed out toward the epicenter of the quake."

In case that you are wondering about your Secretary's activities, he is the Trustee and leg man for several sizeable Church Funds, and has also been a wheel for three years in the merging of three Churches. Currently, he is advising others on the administration and maintenance aspects of such projects, which, strangely, are not simple. . . . Don Severance, at the February meeting of the Alumni Advisory Council, delivered an exceptionally fine tribute to our **Chick Kane.** It was published in the April 1971 *Technology Review.* If you missed it, please

refer to page 104, or drop me a line.—**Russell W. Ambach,** Secretary, 135 Aspinwall Ave., Brookline, Mass. 02146

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Notes from here and there. **Edward Lynch** of Wakefield, Mass., is brief and to the point, "Still enjoying life." . . . **Stephen Freeman, Jr.,** West Lafayette, Ind., has just joined the contingent of retirees. He is now Professor Emeritus of Electrical Engineering at Purdue University. . . . The following from **Anthony G. Tsongas,** "After many years of service in the Department of Public Works of the City of New York I retired last September. During my terminal leave last summer I visited Greece, the country of my birth, where I traveled extensively and visited most of the archeological sites on the mainland and on the islands of Crete and Rhodes. I found Greece extremely interesting—and an excellent vacation at reasonable prices."

Milt Salzman, Lynbrook, N.J., says that there is no change. He is retired from active engineering practice but is doing some voluntary engineering service for the Village of Lynbrook, still active in church work and SPEBSQSA (which concerns barbershop quartets). . . . **Hollis Ware,** Midland Park, N.J., is now on his second one-year extension from "normal retirement" and is with I.T.T. Arctic Service which was formed to operate the DEWline, BMEWS and the White Alice Communications System. . . . **Finley B. Laverty,** Los Angeles, Calif., has recently spent a month in Argentina as consultant to the U.N. Task Force to augment ground water supply through recharging in the drouth-ridden agricultural provinces of Mendoza and San Juan on the east side of the Andes.

I am sorry to have to report the death of **James R. G. Hardy** of Mountain Lakes, N.J., on February 10. He was a retired electrical sales engineer for the Nickel Cadmium Battery Company. He is survived by his wife, Hildegarde, and a daughter to whom we extend our sincere sympathies.

Ben Oxnard has also brought up the question of my place of residence, Foster Street, and Doc Foster. (See previous issue of the *Review*) He questions if that is why I was elected secretary. All I can say is that I have known of persons that have also been selected for "exhaulted" (Ben's word for it) position with less qualifications. Perhaps this gives me an opportunity to introduce myself as your new secretary with a short biography and a comment on the location of Foster Street. I am a native of Canada, Maritime Provinces, but have spent most of my life since the age of six in the greater Boston area. My wife, Madeline, is a Mainiac, and that is probably why we spend most of our summers in that state. I have been a resident of Cambridge since 1932 and at present occupy a small house, something that is a prized possession in Cambridge. It is about one hundred years old and is about ten minutes' walk from Harvard Square between Brattle and Mt. Auburn Streets. As you can see I am not too far from the battlefront: i.e. the same Harvard Square, and within easy distance of M.I.T. so I can visit there occasionally. Also quite a few Tech graduate students live in the area. I retired about eight years ago and find a college town an excellent place to be. We find plenty of things to do without going too far afield. Music, plays, adult education classes, all within walking distance. My hobby is painting water colors and I have more time to pursue it. I do some volunteer work at the local educational TV station where I can help on some of the non-TV activities. As most of our class seem to be already, about to be, or considering retirement I would welcome comments on how they are realizing the opportunities it offers.

In this column I should like to include occasionally my impressions of what is happening here on the firing line, not what you happen to see in the head lines.—**E. Willard Gardiner** (Will), 53 Foster Street, Cambridge, Ma. 02138

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The temptation is to say: "I'll see you in a couple of weeks at Chatham Bars Inn" and sign off. However there are things to report that will not be said at Chatham. . . . If any of you have thoughts of winning the long distance honors, forget it because it seems to be in the bag. **Bill Edwards** (Perpetual Calender) has underlined that Honolulu is 5,100 miles, so unless **Shantanu Kirloskar** quick decides to come from India, Edwards seems to have it. . . . **Eben Haskell** recently wrote that he had "retired from United Illuminating but have become executive director of the Connecticut Research Center, jointly owned by U.I. and Connecticut Light and Power Company. They own over 800 acres of magnificent land in the towns of Meriden and Wallingford, Conn., zoned exclusively for R and D facilities and corporate office headquarters." Eben's job for the next two years is to get the project moving. Eben says: "this only takes about half my time—so I still keep up my activities, as Chairman of the Board of the Quinnipiack Valley Development Corp., of the State of Connecticut, and as Vice-Chairman of the Culinary Institute of America, a non-profit school for chefs and bakers now a world famous school in hotel and restaurant circles. But it's not all work and no play. My wife and I had a great trip to the Canadian Rockies, Alaska, and Pacific Northwest last fall and Florida for a month this winter—and we hope to see you and all the others who come to the 45th this coming June. Sincerely, Eben."

In reply to **"Pink" Salmon**'s recent request to attend a local meeting, **Marvin Pickett** replied: "Sorry, Pink—Believe it or not I am going to night school for a master's degree in sanitary engineering. I just have no time. Best wishes to you and the others." How's that! . . . **Bill Latham** is still resident engineer, Power Authority of the State of New York on the Niagara Power Project. His activity in the Boy Scouts continues at a high level and he was recently re-elected president of the Greater Niagara Council. Hope you make reunion, Bill. I'll bring plenty of aspirin—remember our 20th? . . . **Martin Staley** of San Antonio, Texas sends his regrets but promises to come to the 50th. Martin is five or six years older than the rest of us but proudly continues to operate his consulting engineering business with no thought of retirement.

Gus Peterson hopes to be able to be with us. It depends on his health. . . . **Don Chase** will have just moved to the Cape (Yarmouthport) so he definitely will be aboard. . . . **Walter Lobo, John Fletcher, Doug Jeppe** and **Bernie Morgan** all indicate that they unfortunately will be out of the country. . . . **Argo Landau** and his wife will be with us after a winter in Hawaii and a letter received yesterday from **Frank Schreiner** indicates that he and his wife will be there for the 6th reunion Frank has attended. But why do I continue? If I give you all of the news you will have half of your reason for coming taken care of. Also it's a beautiful morning at Pigeon Cove and we must get out and enjoy it. Cheerio —**George Warren Smith,** Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

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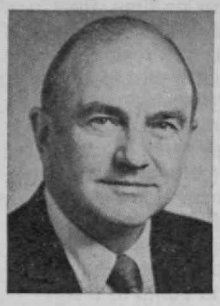
For any of you who were worried, in reading the last notes, that I might not get back in time to write these notes, here I am, after a visit to Mexico. We were mainly in San Miguel de Allende, which is an attractive small town 150 miles northwest of Mexico City. We were also briefly in Mexico City; not long enough to take in the entire Fiesta of the M.I.T. Club of Mexico, but I did attend their luncheon in honor of Dr. Killian. Among other 1927ers were **Manuel Castellanos,** and his wife. After living many years in the New York area and working for American Cyanamid, Cas has now retired to Sarasota, Fla. (2914 Valley Forge St.) and is doing some consulting work.

Dick Cheney has been named the first full-time president of the Glass Container Manufacturers Institute, of which he had been executive director since 1957. He originally joined this organization 26 years ago. His other activities now include presidency of the Disposal Research Council and membership in Mayor Lindsay's Committee on the Environment of New York City; he is also treasurer of Keep America Beautiful, Inc. Just recently, Dick has been made a member of the executive committee of the Boy Scouts' S.O.A.R. (Save our American Resources) program, and advisor to the National Center for Solid Waste Disposal. I'm glad that after reading the above in the press, I received



R. Cheney, '27

N. Cohn, '27

a letter from Dick, giving his thoughts on this increase in responsibilities—while many of the rest of us are retired or retiring. To quote him: "This definitely cannot be called a 'tapering off period' as far as I am concerned but I love it and really think that we are making a substantial contribution toward solving a couple of the nation's environmental problems." Dick included some news of others in the Class: "I see **Bud Fisher** at intervals. He is busier than ever in his retirement, although he now does try to take Fridays off. He is most active in the New York Blood Bank operation.

"**Bob Bonnar** is evidently still active in the chemical business, as I saw him the other evening at the annual meeting of the Drug, Chemical and Allied Industries Association. . . . Have done some horseback riding on Saturday mornings with **Anson Rosenthal.** . . . As **Pub Whittier** wrote you, he is acting as a consultant to our organization now and making a very valuable contribution to our activities, as you would expect. Even so, unfortunately, we rarely get to see each other in person." Just to add, Dick, that we are all behind you in your environmental work.

Added to his many other honors, **Nat Cohn** has been elected president of the Franklin Institute of Philadelphia. In the International Federation of Automatic Control, Nat is the chairman of the Technical Committee on Applications, has been an American delegate to each of I.F.A.C.'s triennial congresses, and is now chairman of the Planning Committee for the federation's congress to be held in the United States in 1975.

Francois Rousseau, who has been chief engineer of the power development division of Hydro-Quebec in Montreal, has received the Julian C. Smith Medal for achievement in the development of Canada. The presentation of this medal, a major award of the Engineering Institute of Canada, was made at the 1970 annual general meeting of the Institute.

The *Commerce Digest* of January, 1971 has an interesting article devoted to **Frank Massa**'s amazing development and production of electroacoustic transducers, as president of the Massa Division of Dynamic Corporation of America, Hingham, Mass. Frank earned his B.S. in electrical engineering in 1927 and his M.S. in 1928. He was with R.C.A. Victor in Camden, N.J., for 12 years in pioneering work in electroacoustics, and during the war years was with the Brush Development Company in Cleveland, Ohio as director of acoustical engineering, in charge of sonar transducer research, connected with anti-submarine warfare and acoustic mine equipment. The Massa Division, founded after the war, has now completed twenty-five years of success in its field, today more critically important in defense than ever before. Frank Massa Jr., M.I.T. '68, is vice president of the division. Frank has written four textbooks and innumerable papers in his field and holds more than 60 patents for electroacoustic devices.

In Memory

James Raymond Buckley, who retired four years ago after a life-time career with du Pont, died at Maple Shade, N.J., last December 20. He was born in Washington, D.C. and came to M.I.T. from George Washington University in his junior year, graduating in chemical engineering. Later, he studied industrial organization and management at Rutgers University. Ray's work with du Pont started in the Parlin, N.J. fabric finishes laboratory. Then followed several technical and manufacturing supervisory assignments. In 1945, he was manager of the Flint, Mich. plant and in 1952, manager of personnel, Fabrics and Finishes Department, which post he held until his retirement. I remember with much pleasure the period 1945-51 when Ray was manager of the Fabrics Division in New York and we were neighbors.

Joseph L. Burke died July 23, 1970. He came to Tech from Woburn, Mass. High School. To our knowledge, he had lived in Danvers, Mass., from 1950 to 1970. He had been plant superintendent of the A. C. Lawrence Leather Company of Peabody, Mass.

From Burger to Witham

Walt Burger, who retired two years ago as supervising architect of the Chicago Board of Education, is seeing the world: Orient, Spain and Portugal, Italy. . . . **Larry Cheney** writes: "Have been retired nearly four years. Feel like a native here in Old Greenwich, having lived here twenty years, and now the house will be paid for this year! Still teaching in our adult education program." . . . A very good set of pictures of our 25th reunion at East Bay Lodge has been received from **Jim** (Dice) **Coburn.** Practically everyone who was there is in one of the shots. Apparently there was swimming, beer, golf, beer, tennis, beer, etc. They will be sent on to **Joe Melhado,** as we are not going to let him forget he is class historian. Dice adds that he is enjoying retirement and checks in often on his six grandchildren—two in New Orleans and four in Trenton. . . . **John Donald** reports a Scarsdale address instead of A.T. and T.-New York. Maybe a retirement. . . . **Tom Knowles** has been to Hawaii. "A real restful stay—catching up on reading old magazines (including the *Technology Review*)." . . . **Dick O'Donovan** seems to have made a short move from Miami to Coral Gables, Fla.

We have first word of an address for **Roger Peirce** in West Brookfield, Mass., formerly Worcester. . . . **Anson Rosenthal** has a new East side apartment at 235 E. 73rd St., New York. . . . First word in a long time from **Tom Scott**: "Am still with the U.S. Tariff Commission in Washington, D.C., now having over 35 years in government service. In 1969, I made a round-the-world plane trip with my wife and last year we attended the Passion Play at Oberammergau with our daughter, a second year law student at the University of Virginia. Our son, Tom Jr., who graduated from Yale in the class of 1965, is a naval helicopter pilot on the U.S.S. *Oklahoma City,* stationed in Japan. . . . **Winfred Witham** has moved from Redlands to Aptos, Calif.—**Joseph S. Harris,** Secretary, Box 654 Masons Island, Mystic, Conn. 06355

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Early in March **Leon Gaucher** presented a paper on the origin of petroleum. It was given at the meeting of the American Institute of Chemical Engineers in Houston, Texas. Leon's thesis is that the enormous deposits of petroleum now known to exist in the earth's crust must have formed in a very hot atmosphere early in the earth's history. This modern view attributes the formation of hydrocarbons and other organic species to the reaction of hydrogen with carbon monoxide at temperatures between 1000 degrees F and 400 degrees F. It is suspected that a similar condition exists at present in the hot atmosphere of the planet Venus. Leon retired from Texaco, Inc. in 1969 after 41 years with the company. His wife, Hattie Lu, died in January of last year. Son Donald is with Humble Oil Company in Houston where he lives with his wife Jane and their daughters Susan and Beverly Jane.

We were pleased to have this cheerful letter from **Fritz Rutherford**: "My wife Jo and I still live down here in the deep South near Beaufort, S.C. which is between Savannah, Ga. and Charleston, S.C. It is just across from Parris Island Marine Recruit Depot on St. Helena Island. We still do a lot of traveling. Last year we took a motor trip through England, Wales, Scotland and Ireland which was marvelous in spite of the heavy dew each day. Last fall we went through the canyon country of northern Arizona, southern Utah, western Colorado, and New Mexico. We have been in all parts of the world but there is nothing anywhere to compare with the scenery in those states. We always recommend 'See America first then travel abroad.' We are busy on various civic boards, doing lots of golfing, hunting and fishing, and entertaining our 'Snow Bird' friends from the Northern Yankee country. We are looking forward to another grand time at the 45th!"

During the more recent of two evening

Leon Gaucher, '28

telethon sessions for the Alumni Fund, **Jim Donovan, Roger Haven, Gus Solomons,** and **Walter Smith** had the pleasure of chatting with many classmates. . . . Upholding his reputation as our star reporter, Jim has sent in the following four items of news. **Bill Hurst** in a recent letter deplores some of the things that have happened at the Institute but still holds a warm regard for the place. He has especially a lasting respect for his classmates. . . .**Trudy Francis** has been busy visiting her children and Don's family as well. She is still living at her home in Florida and reports no problems. . . . Mary and **Max Parshall** sent in some beautiful color snapshots taken at their home in Hamilton, Montana. They show some of the background scenery—we can well understand the Parshall's enthusiasm for their location. Both of them look well in the photographs (with Max holding a steelhead). Mary's health has improved but she has given up much of her piano teaching. Max is very busy but he does have an interest in a refuse disposal system which he believes merits some serious development work (by someone else). . . . **Arch Archibald** wrote briefly about a trip last fall to Japan, Hong Kong, and Australia. Clara went with him. He says: "There are tensions in Japan, lots more in Hong Kong, and even a few in Australia—yet we were not concerned when walking around in odd places. We had no feeling that violence might suddenly erupt. The pleasant atmosphere of Australia is becoming increasingly attractive to citizens of the United States."

Des Shipley sent in a brief note to congratulate Jim on his Beaver award. On another recent occasion Des mentioned that he was to take off on a trip to Greece. Hopefully he will write again and tell us about it. . . . **Abe Woolf** was presented the annual Man of the Year Award by the Brotherhood of Temple Beth Zion at a breakfast given in the Temple on January 24, 1971. Abe has long been active in Temple Beth Zion as a vice president and as chairman of the finance committee. You will recall that Abe was chairman of our highly successful 40 year reunion on campus in 1968. **Herman Jones** has sent in a discussion of his views on economics and foreign trade. This is a subject on which he has been writing for a number of years. His letter, with attachments runs to a dozen pages. It is obviously the product of much thought. We will try to report upon it in our next issue. . . . **Dave Bradshaw** has retired as vice president and director of the TV-Radio department of Young and Rubicam, Inc. of New York City. According to the news release Dave's first job in 1929 was with the old Movietone News Company (movie newsreels). He left in 1935 to join Time, Inc. where he was assigned to the "March of Time". There he became associate producer and remained until 1951. He then joined the TV department of Young and Rubicam as the producer of "We the People." Dave expects to write a book about his experiences with newsreel, radio, and TV program productions. Dave and his wife live in Larchmont, N.Y. They have two daughters. Carol, a graduate of Bennett Junior College, is doing graduate work in Spanish at Adelphi. Their younger daughter, Marilyn, is a junior at Finch College in Manhattan.

We are very sorry to report that **Charles L. Hibbard, Jr.** died on February 20, 1971. Charlie had been ill for a long time and because of poor health had retired in 1964 from his firm of Larson, Bradley and Hibbard in Boston. He was born in Pittsfield, Mass., where his father was a senior judge. He graduated from Williams College then entered M.I.T. to study architecture. He worked on several well-known buildings in Massachusetts including: the Herald-Traveler in Boston, Curry College in Milton, and the Berkshire Mutual Life Building in Pittsfield. For 14 years he was a member of the Board of Managers for the Home for Little Wanderers. Active in Masonic affairs, he was a past Master of the Lodge of St. Andrew. Besides his wife, Grace, Charlie left two children and eight grandchildren.

We regret also to report that Miss **Alice M. Browne,** R.N., an honorary member of our class, died on March 15, 1971. Brownie, as she was popularly known, was a nurse (and for many years *the* nurse) in the M.I.T. Clinic (now the Medical Department), until her retirement in 1961. Her career at the Institute began at about the time the Class of '28 was initiated. Brownie received her training at Brooks Hospital in Boston where Dr. G. W. Morse (then the first M.I.T. Medical Director) was Chief of Staff. Many will remember Brownie with affection as the nurse who not only treated injuries but could be a student's confidante in time of trouble. Although ill and inactive in recent years, Brownie had the comfort of knowing that she had many devoted friends among the alumni. —**Walter J. Smith,** Secretary, 20 Waverly Street, Arlington, Mass. 02174

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Richard T. Hoffman, Course VI of Memphis, Tenn. writes: "A few years ago, I was granted patents on methods of dredging, comprising systems for management of gas released from material during hydraulic dredging thereof. These inventions were characterized by the late Henry G. A. Hayward, Consulting Engineer, as the greatest boon to dredging of our waterways since the invention of the centrifugal pump."

This is your last opportunity to get in your reservations for dinner and Pops on Sunday, June 6. As of this writing, the following members will attend accompanied by wives and guests: Bill Bowie, Karnig Dinjian, Paul Donahue, Edward Farmer, Walter Gale, Francis Mead, Herman Meissner and John Rich.

A letter from the widow of **George L. Todd,** Course XIII, of Denver, Colo., gives the following details of his death on October 18, 1968: "Dear Mr. Dinjian: Thank you for your very kind letter concerning my husband's death. Commander Todd died October 18, 1968 following a lengthy illness, and he was buried with full military honors at Fort Logan National Cemetery. He attended M.I.T. in 1928 and 1929 in the Department of Naval Architecture and Marine Engineering. During the war, he served in the navy in Washington, D.C. at the Bureau of Communications. He was personnel director and treasurer of Butler Paper Co. We had no children and I was his sole survivor. Thank you again for your interest. Sincerely, Louise E. Todd."

John Ade Plugge, Course IV, of Chevy Chase, Md., writes about the tragic death of Frank W. Horn, who later changed his class affiliation as follows: "I am not sure that you have heard of the sad death of our classmate, **Frank W. Horn.** Frank was in excellent health and had an enjoyable trip to Alaska with his wife touring our Pacific Northwest by car. Upon their return they were invited to a luncheon where Frank suffered food poisoning, went into a coma and died after seven weeks of intensive medical care."

A letter comes from **Eric Bianchi,** Course II, of Summit, N.J., announcing his short-lived retirement as follows: "Dear Karnig: I am overdue writing you to express my appreciation for the great job you have done in continuing the monthly notes of our class. Perhaps as we get older we have more time to keep you up on our activities. At the end of 1970, I left Studebaker Worthington on what was anticipated to be a retirement. However, retirement does not yet have an urgent appeal and since Kay wished to stay in our present location, I cast about to find something that would keep me occupied. I am now vice president of Search Associates in Summit, N.J. The office is within easy walking distance of my home. This is a most acceptable substitute for the daily commute into New York City. Search Associates works with corporate clients in finding needed executive talent. While 'head hunting' may seem like a

doubtful occupation in the current economic climate, I am sure that things will improve as the year 1971 moves along. I have not seen any classmates recently so can only bring you up to date on my own activities, though we visited the Gales last July. Sincerely, Eric Bianchi."

A note from **John P. Rich,** Course IX, of Nashua, N.H. to Frank Mead reads: "Olive and I would be delighted to have dinner and go to the Pops on Sunday, June 6. I have no significant news for Karnig other than the now much discussed fact that I will be retiring in midsummer and that if all goes well, Olive and I will plan a six-week cobweb cleaning trip through Europe by car. After that—who knows. Sincerely, John." . . . Another letter written to Frank Mead comes from **Bill Bowie,** Course VI, of Slingerlands, N.Y.: "Your outline is an interesting proposal for Homecoming activities. Sally and I have always been interested in the Boston Pops and would enjoy the program you have proposed. We are toying with a Scandinavian trip for early summer but have not firmed it up yet. Probably it could be scheduled after June 6 so we could get to Boston for some of the festivities. I have no particular news to add for Karnig except to acknowledge my retirement which, incidentally, is off to a good start as of February 1 after a month's vacation. We are dividing our time between Slingerland and our place in the mountains, where we are for a week now. It is real winter here with about 36 inches of snow on the level ground. We had to have a bulldozer in yesterday to push back the snow when it became too much for my Ford 600 plow."

Bill has been working for New York Telephone Company ever since he graduated from M.I.T. His association has included a variety of assignments in plant engineering, commercial marketing and administration. At the time of his retirement, Bill was responsible for all communications for New York Government as well as for the Federal Government in upstate New York. He is a senior member of I.E.E.E., member of Albany Engineering Society, past president of the Albany Symphony Orchestra and president of the Albany Council of Community Service. . . . **Charles W. Meadows,** Course VI, of Schwenksville, Pa., has just retired as president of Medcraft Electronic Corp. after 25 years of service. Medcraft is active in the nuclear, health and environmental, and advanced materials areas. . . . Best of health to you all.—**Karnig S. Dinjian,** Secretary, 32 Oldham Rd., Arlington, Mass. 02174

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Again this month we have notes from two retirees, **Dick Boyer,** who merely said "retired" and **Ken Bucklin,** who went all out and put down "retired from R.C.A." From my records, which are rather old, it appears that Dick was vice president of Anken Chemical and Film Corporation. The Boyers are now living in Pine Grove, Pa. . . . My records indicate that Ken was manager, commercial engineering, R.C.A. electronic components and devices in Harrison, N.J. The Bucklins now live in Ormond Beach, Fla., where Ken is secretary of the local Kiwanis Club and has an amateur radio station (call K4LP). The Bucklins have two married daughters.

Palmer Boggs is a professor of architecture, teaching applied structures and structural theory at the University of Arkansas in Fayetteville and also doing some consulting work. The Boggs have three children: James, who is completing his Ph.D. work in anthropology at the University of Oregon; Meredith, who is teaching at the International School in Frankfurt, Germany; and Jacqueline, who works as a speech therapist in Palo Alto. . . . **Reg Bisson** lives in Laconia, N.H., where he owns a building construction firm operating north of Concord. He is a trustee of the Laconia Savings Bank and the Taylor Home for the Aged and a director of the Laconia Rotary Club and the Greater Laconia Weirs Beach Chamber of Commerce. The Bissons have four children: William: M.I.T. '60, who is also a graduate of the Boston Architectural Center; Elizabeth, who graduated from University of N.H. and is teaching in Salem, Mass. Junior High; Robert, who is a senior bioenvironmental technician with a firm of consultants; and John, who is a part-time college student and substitute teacher. Reg says that he has noted the retirement of an increasing number of classmates each year "but for economic reasons must perforce continue to remain fully active for at least a few more years . . . would like to enjoy extensive travel, etc., but earning the daily bread isn't so bad, as long as good health continues." . . . **Jack Bloom** retired from his job as a patent examiner some years ago and is living in Bonita Springs, Fla. He has "no business connections, no work, no troubles and no problems" and is practicing loafing on a large scale. He has apparently offered free advice to the Lee County Engineers from time to time without receiving a very kindly reception. The "county engineers in Lee County are totally impervious to all thoughts based on my education and experience. They are further goldbrickers to a magnificent degree . . . The stupidity, waste and anti-social attitude is appalling." Jack says he is an "expert specialist on the subject of retirement" and would be glad to answer any specific questions that you other retirees might care to present to him.

Ted Bridge works for Catalytic Inc., in Philadelphia, "trying (unsuccessfully I fear) to get more engineering work on computers" and apparently thoroughly enjoys his work. The Bridges live in Swarthmore where Ted spends his spare time keeping a 100-year old house in repair and doing some work at the Providence Quaker Meeting where he goes to church. He is quite concerned about the way M.I.T. has changed since our time and commented in part as follows: "I was always proud of M.I.T. One reason, I think, was because it seemed to cater to lop-sided (screwballs) people like me. . . . It seems to me that the glory of M.I.T. has been in its one-sided specialization, its dedication to the education of screwball technocrats . . . Let the other schools go in for well-rounded education. Let M.I.T. keep its emphasis on *technology.*" . . . Changes of address: **John M. Hanley,** 10353 Fieldcrest Court, Apt. 404, Omaha, Neb. 68114—**Gordon K. Lister,** Secretary, 530 Fifth Avenue, New York, N.Y. 10036

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Robert I. Phemister will retire in April after 29 years with Monsanto. He writes: "My wife and I will move to Fort Collins, Colo., a few months later. One of our sons is an associate professor of pathology at C.S.U. and lives there with his family. We want to enjoy the experience of being part of our grandchildren growing up. Our two other sons, both lawyers, are also married and have children. One lives in the suburbs of Chicago and the other in Shaker Heights near Cleveland. We would like to, but obviously can't, be near all of them so we have chosen the more inviting (to us) of the three areas."

Stephen Lichtblau who earned a master's degree in meteorology at M.I.T. in 1932 after taking his bachelor's degree at Case has retired after 35 years of service with the Weather Bureau. He held the position of meteorologist in charge of the New Orleans National Weather Service Forecast Office. He entered the Weather Bureau at Chicago in 1935, served at several other stations and as regional director for Alaska before coming to New Orleans in 1943.

Louis Vassalotti writes that he has built a new year-round house in North Falmouth, Mass. and moved in last November. They see the Pearces and the Nealands occasionally and are enjoying the Cape very much. Lou says drop in, the door is always open. Telephone Falmouth 563-3966.—**Elwood W. Schafer,** Class Secretary, M.I.T. Rm. 13-2145; **James Harper,** Assistant Secretary, 2700 So. Grant St., Arlington, Va.

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Top billing this time to **Vivian Drenckhahn,** one of our gals who took degrees in the old Biology and Public Health Course. Vivian is retired, so she says, and is on a six-month assignment for World Health; last fall in Thailand and Bangkok with UNESCO, thence to the WHO office in New Delhi, and finally Geneva via Rome. I expect that the World headquarters are still in Geneva. To Vivian the WHO is a stimulating and exciting experience. Many thanks, Vivian, from us all. . . . **William** (Bill) **Bauer** is finally settled as to homes,

having bought a place in Dunedin, Fla. for their winter occupation. They will live summers in Southern New Hampshire, right in our backyard. Thanks Bill, and best to Claire. . . . **Cyrus** (Cy) **Hapgood,** has the commuting problem solved. Davis, Hoxie, Faithful and Hapgood, patent attorneys, have added a branch in Stamford, and Cy will spend three days a week there, and two in the Manhattan office. Two of the Hapgood children are married, and the third daughter is attending Denison (Ohio). Cy has two grandchildren through his eldest son. Great stuff, Cy. Thanks a million. . . . From the ever alert **Cal Mohr** comes word that **Robert** (Bob) **Smith** has retired from Pfaudler, and the Smiths have set up in the antique business, full time now rather than part. We have only Walt Swanton left with Pfaudler. . . . Cal also hears that **Adam Sysko** has not yet retired from duPont, as was rumored. The Syskos have three grandchildren, all by daughter Judy. However, their six-foot-six son and wife expect to add another soon. Thanks, Cal. If these characters will not write, you are truly the next best answer.

John Mattill, Editor, informs us through his own mail information that **Don Fink** recently walked into a rising sidewalk elevator and picked up a few broken small bones and a dislocated elbow. Surely Don is over all that by now, but he did not tell us himself, the cur.

We have rather a long letter from **William** (Bill) **Gray** informing us that he has become a grandfather the easy way—by marrying a beautiful grandmother in 1963, Nancy by name. Regrettably, it is impossible to include here more than a poor resume, to wit: two of Nancy's children are doctors, and one more is an electrical engineer. Bill himself is doing a bit of part-time consulting, is also a five-acre farmer growing boxwood for the market, and appears to be doing well. One quote: "our hobbies are the preferred vices: horticulture, historical research and writing" (to whom?). Nancy seems to be specialty cuisine chef. Bill, we appreciate your nice letter and may look you up about the time you read this.

We hurry to correct an error in a previous column. **Walt Duncan,** and a few others, tell me that there were at least seven, and maybe eight, 1933 men who attended Phillips Exeter Academy. So it does pay to make mistakes. We must give **Clint Backus** a credit, also for the above comments. . . . Short, and not overly sweet, comes a bit from **Allan A. Hinkle.** The Hinkles have no children, hence there can be no more family. However, Al does some collecting, what, he sayeth not. They have been to Europe. Al serves on the Utility District Commission, and is semi-retired. Golly, that was brief! Perhaps I should have sent him a stamped envelope. Haw!

And now we have a rather long one from **Bill Conant,** who lets us in on the family. Son Roger, formerly a tennis pro, is now a part of a brokerage house. Daughter Marsha is married to an Air Force captain, and lives in Dayton where hubby is attached to his unit at Wright Patterson Base. Marsha seems to be intensely interested in counseling work with teen-agers in trouble . . . The **John D. Howells** had a fine trip to the Virgin Islands over the Christmas-New Year's holidays, staying with old friends, enjoying trips to several other islands, playing some bridge; they even had tea aboard the *Queen Elizabeth II* (tea and crumpets, sez he). Bill, we sure love to hear from you, and we hope that we can help out if you need info on other classmates. Thanks very much, indeed.

Once in a while, this old heart is gladdened by something special. From Ruth and **Neil Hopkins** comes a note, and a long clipping about daughter Mary's wedding to Roger C. Miller, a, student at Penn State. The unique phase is the fact that the wedding was celebrated in the Chapel at M.I.T. with the handsome father of the bride giving his daughter away, after that short hike down the aisle. The reception was held at the Faculty Club. Mary Elizabeth and her groom (I gather) are graduates of Brown University, Roger then going to Penn State, and Mary to M.I.T. to study for her Master's degree. This suggests why they made such excellent use of the Chapel. Neil announces that he is about to join the retirement club of Borg Warner, York Division, though he did not say just when, though I gather that it might happen before the 40th. We are somewhat concerned with Ruth's health, as she seems to be afflicted with Parkinson's disease. Well, Hoppy old boy, you were always ten feet tall to me. Many, many thanks for such a nice reply to my card of implorement.

Now comes **Arra Steve Avakian,** one of our brighter group, who has left science (aerospace) and is now a full professor of ethnic studies at Fresno State, California. His specialty is Armenian studies, teaching, writing, lecturing and research. Arra S. was in on the ground floor as Fresno was just starting the ethnic studies department, and he took over his own specialty. Arra S. had a most interesting experience this past August, while on a trip, apparently to brush up on his Armenian ethnic program. He intended to climb Mount Ararat but while travelling by train from Soviet Armenia to Istanbul he was detained by the Turkish police because of some misunderstanding. After two days of intensive questioning he was released, but was not allowed to enter Turkey, so had to go to Iran, where apparently he was at least tolerated. Arra S. has apparently made too many visits to this section of the Middle East, which seemed to nettle the Turks. So, they just put him out. I guess the Turks don't care for us Armenians. He is starting work on a 3-part TV program on Armenia: the language, the land, the people and their culture. Arra S. was honored recently by the Armenian church for his 50 years of service, which started as an altar boy in his native Fresno, where he graduated from high school before entering M.I.T. in 1929. At the testimonial dinner he was honored with the A.S.A. Sarafian Award which is presented annually to an Armenian who has made outstanding contributions to his community.

The Avakian family is also unique: daughter and her husband, both astrophysicists, are studying and working at the Mt. Stromo Observatory in Canberra, Australia. "My be-childrened daughter has decided to complete her studies in French literature, having already, last year, her master's at U.C.L.A." I can't expand on the hyphenated word above. The "other end of Mass Avenue, (Harvard)" son has too good a job at the Harvard Computer Lab, so will not go on with his graduate studies. Well, Arra S. you sure came through at a time when you were really needed, and we all appreciate hearing from you. Many thanks and good luck.

Now comes **Gorham (Pete) Cluett,** who is retired, lives in Florida winters, and has for 14 years, and in Milton in the summer. The Cluetts have three children and eight grandchildren, which is a fair start, as Guido Garbarino might say. Mrs. C. is a garden enthusiast and Pete is a radio ham. They do a lot of travelling in Florida and also visit their progeny in Columbus, Ohio, Haddonfield, N.J., and in Andover, Mass. . . . From **Dick Fossett,** we have a fine note. Dick says that he is a poor correspondent. Not so Dick; you are a good correspondent, albeit erratic. He is still with Procter and Gamble, doing odd jobs in the food division. Dick sees few classmates but does keep up with M.I.T. through the Educational Council. Living out there, sezzee, has its compensations, like the mild climate and the smog. So he and Charalee get away from it all by going skiing and mountaineering. With too much ice on the slopes, Dick dislocated his shoulder recently. A few years ago they spent the summer skiing in the Swiss Alps. So, encouraged, they studied up on their Deutsch, and were able to get along in the Austrian Alps this past summer. Their three children are married, and there are four grandchildren. Dick III and Linda live near them, and son Steve is in Chicago, but travels plenty, having just returned from Colombia, Ecuador, and the Amazon basin. Dick says that it is fun to write me, and hopes that some of it is interesting. My! my! I do hope that a few more of you fellas will find it fun to write me. Well, it must be evident that it is fun getting letters from you fellas. Were it not, there would be no compensation in this particular job. We appreciate hearing from you and Charalee, Dick. How about a card or two from Austria?

Dupuy F. Cayce stops long enough to say that he is still in Phoenix following the Honeywell-General Electric Exchange of computer operations. . . . We have a few address changes, to wit: **Eugene Nedbor,** CE; **Arra S. Avakian,** MA; **J. Mason Culverwell** ML; **Robert Heggie,** CM; **Outerbridge Horsey;** MG. These address changes are, as usual, all in our

files and are available by request if letter is accompanied by the family story.

We are saddened to tell of the passing of **William E. Ward,** of St. Paul, Minn. Bill passed away in February, 1970, far too long ago for us to do much about the event. We have been in touch by mail with Bill's widow, as is our custom. I know that you all will join me in what I had to say at this difficult time, for those who survive.

Due to an unavoidable retrenchment policy on the part of the *Review,* you will note that this column is running, and will run, quite a bit shorter. Please bear with us, and do not be unhappy if you should turn in to me a long story and then find it quite a bit foreshortened. We do not assume any responsibility for policy, as that rests with the Institute itself. I find it just as hard to cut down the essay, as it was to write one much longer. That's it.—**Warren J. Henderson,** Secretary, 1079 Hillsboro Beach, Pompano Beach, Fla. 33062

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I am very sorry to have to report the deaths of two more of our classmates; **Wilbur M. Jones** and **John T. Burwell, Jr.** Wilbur died in September 1969 but I only recently got word of it and have no information about the circumstances. John's passing was much more recent, on March 11, 1971, but again I know nothing about the cause. John had continued his studies at Tech and received his Ph.D. in 1938. He taught at M.I.T. from 1938 to 1951 when he went to Horizons, Inc. He was a vice president of that firm when he left in 1956 to become director of research of American Standard. In 1962 he was promoted to vice president for research, the position he held at his death. Obituary notices are not exactly the high point of putting together notes like these. Especially when they concern people that you knew in school or have had contact with since. So I would like my personal regrets to reinforce the sympathy that our class expresses to the families of Wilbur and John.

In a lighter vein, it would appear that **George Bull** had his own technique that he used when he was helping in January. Make a small error in an item about someone; they write in to correct, and presto—more copy. It works, as witness the following from **Bill Schumacher.** Bill writes: "Dear George—This is, first of all, a note of appreciation for the mention in the January *Review.* One small amendment: the son who came home from the Navy is Bill, my eldest, not Paul; and Bill has landed a job in a related capacity with Metropolitan Electric in Middletown, Pa. Walter became engaged to Valerie Christian of Glendale, N.Y. just before Thanksgiving. Mary has been accepted by Dickinson College on their early admissions program and will start next Fall." Thanks for the corrections, Bill. We're glad to get things sorted out properly.

Egor Popov has received further honors from the American Institute of Steel Construction. He has been named the recipient of the 1971 Theodore R. Higgens Lectureship, an award that recognizes the most significant engineering paper on fabricated structural steel. This award includes both a citation and a substantial honorarium. . . . **W. Arthur Smith, Jr.** was good enough to return one of the post cards I had sent out. He and his wife Jane have two married daughters. He adds: "In business for myself—manufacturer's representative, designing and selling special bearings and gears. My hobbies: flying and loafing."

From Toronto, via the Alumni Fund, comes a brief note by **Elizabeth MacGill.** For three years, from 1967 to 1970, she served as a Royal Commissioner on the Canadian Royal Commission on the Status of Women. In checking the Alumni Register I find that Miss MacGill is with Elsie Gregory MacGill and Associates. I think it would be interesting to us all to hear something more about her work. It would seem that she has found one answer for the Commission.—**Robert M. Franklin,** Secretary, Satucket Rd., Brewster, Mass., 02631; **George G. Bull,** Assistant Secretary, 4961 Allan Rd., Washington, D.C., 20016

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During my last sales trip to Chicago, I had an opportunity to sit down for a few minutes with **Boyd B. Brownell** whom I had not seen since our Course VI classes. Boyd is general manager of the Electromotive Division of General Motors at La Grange, Ill. He has been with G.M.C. for 34 years and with the E. M. Division since the building was being planned. He gets back to M.I.T. each April as he is on a committee to interview G.M.C. Scholars at M.I.T. The E.M. Division builds diesel electric locomotives which are sold all over the world. Boyd feels strongly that the private railroad industry could "do the job necessary if it weren't being regulated to death." . . . If **John R. Burton** or **Norman Kornetz** see these notes, I hope they will take time to write to Boyd who was wondering where they are and what they are doing. And send a copy of your letter to the Class Secretary, please!

I was not able to get out to Aurora, so I telephoned Betty and **Paul Daley** from my hotel. Paul was hit by a massive stroke a year ago, and although he is still at home he has made a remarkable recovery. They both sounded bright and cheerful on the phone and hope to be at our 40th. Paul would be delighted to hear from his friends. His address is: 1310 Garfield Ave., Aurora, Ill., Phone 312-892-7136. . . . Mr. and Mrs. **Bernard Nelson** and Mr. and Mrs. **James Fisk** are on the planning committee and patrons respectively to the music festival being given in New York as a tribute to Dr. and Mrs. Killian on the occasion of his retirement as Chairman of the M.I.T. Corporation. The festival dates are March 30, April 19 and May 11. . . . **Leo Beckwith**'s oldest daughter Carol won a year's traveling scholarship from the Boston Museum and will spend most of the time in the Far East. Carol, who is a very talented young lady, sold several of her paintings to help finance the trip. Betty and Leo spent some time in an apartment at Palm Beach and rode down on the same plane as the **Bill Abramowitz**s. Bill had open heart surgery last November and was on his way to rest and recuperate. Bill has come through his ordeal just fine as the following letter from him attests "It was very pleasant to receive your letter. Operations are serious only when you don't recover, and since I am alive and kicking, it couldn't have been so serious. Fortunately, it worked out very well and my favorite current joke, which is not true, is that I have a 30-year old heart and a 50-year old wife. My wife doesn't even think this is funny.

"I am glad to hear that Astrodyne has survived the technological adversity that has hit most of the engineering industries. I didn't realize that your children were still so young. One high school junior, two sophomores and an eight-year-old to put through college is a job for anybody. However, I have a solution that might help. Pretend you have two more to send through college, which will really make your problem horrendous. Then, assume that one gets through on a free scholarship and expenses. It will be such a relief, that you will be able to donate the savings on the second non-existent student to the Class Gift.
At present, I am working two to three hours a day, in Florida, and hope to be back in reasonably full activity in April or May. As far as my business activities are concerned, I am still involved with A.R. and D. and a chemical company, Millmaster Onyx Corp. I am Chairman of the Board of Medicon, Inc., a small manufacturer of medical supplies, and three or four other companies, half of which I wish I were not in. If there is anyone in the class who would like to buy some potentially profitable companies cheaply, right now, I would be very happy to show them how they can make some good profits with minimum risk. Our house in Swampscott is up for sale and we have taken an apartment at 10 Emerson Place, at Charles River Park, where we would be delighted to receive any members of our class. Incidentally, Governor Sargent lives in the same building, and my son had him as a captive in the elevator one time asking him whether he believed young men should be drafted to go to Viet Nam. I felt sorry for the Governor when I heard the story."

With ideas such as the above, it is plain to see one reason why our class has such a fine record of gifts to M.I.T. and the Alumni fund. . . . If you have not sent in your entry to the 11th Annual Class Golf Tournament, please take care of it immediately. We are shooting for two

flights of 16 this year. . . . **Gerry Rich** and **Ham Dow** live in California where they can play golf all year. They were partners in a St. Patrick's Men's Tournament at the Villages and finished in fourth place with a net Best Ball of 62. I am arranging my business schedule to be Ham's guest-partner at the Annual Evergreen Invitational on June 18 and 19. If we solve the "sitter" problem, Doreen will be with me including a week-end in Phoenix en route.

I have some new addresses which you may wish to note: **Robert J. Anderson** has moved from Weston to 31 Skyline Drive, Wellesley. **Oliver Hoag** is now at Overlea Road, North Bennington, Vt. **George Bartlett** is now located at Cricket Drive, Sturbridge, Mass. . . . Am I being too optimistic to hope that with warmer weather you may now be able to write more easily? A happy May to you and yours.—**Allan Q. Mowatt,** Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

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Coming very soon: Our 35th Reunion at Jug End, South Egremont, Mass. from Friday, June 4, removing to Cambridge after a Polynesian Luau on Sunday. . . . If you have been procrastinating, here is the last reminder!

Forty-six of the Class responded to the appeal for a contribution to get the ball rolling. (Those starred have also at this writing, March 29, sent in their reservations). Heard from are: Norm Bull, Gerard Chapman, John Chapper, Elmer Davis, John Easton, Albert Emerson, Bill Garth, Bob Gillette, Bernard Gordon, Eli Grossman, Jack I. Hamilton, *Marshall Holcombe, *Alice Kimball, Roger Krey, Hank Lippitt, *Loreto Lombardi, Brent Lowe, August Mackro, Walt MacAdam, Henry McGrath, Donaldson McMullen, Herbert Metten, Spencer Mieras, Hal Miller, Dick Morton, *Bill Mullen, Macdonald Nyhen, Phil Ober, Frank Parker, George Parkhurst, Ruth Perkins, Frank Phillips, George Robinson, Bill Royce, Dorian Shainin, Larry Sharpe, Stanley Smith, Louis Stahl, *Ariel Thomas, *Fletch Thornton, Lee Tolman, Mike Tremaglio, Roman Ulans, Bob Wead, and Pyam Williams. Sending reservations are also Bill Fingerle and Elliott Robinson. . . . **Lou Smith** and **Wally Sylvester** joined the committee for its March meeting. Wally, vice president of Panta, Inc. just happened to be in town between trips.

The New Englander for last November featured an article, "Compugraphic Sets a Fast Pace for Printing" which describes in detail the remarkable growth of this ten-year-old company of which **Bill Garth** is president and co-founder. From its new headquarters in Wilmington, Mass., the company "is shipping out phototypesetting machines just about as fast as it can make them." . . . **Charlie Holman** has joined Reichhold Chemical as a vice president and by this time may have already moved from Pittsburgh to White Plains. . . . The Robertson Paper Box Company of Montville, Conn., has announced the election of **Pyam Williams** as a member of the Board of Directors. "Py" is vice president in charge of engineering and research.

In the same mail with the list of changes in address new since the class directory was published last fall I received notice of several other changes which I report forthwith: Joseph T. Branca, 30 Elmwood Ave., Wollaston, Mass. 02170 Carl A. Hedberg, 260 S. Beverly Dr., Beverly Hills, Cal. 90212 from Denver and Philip Major from Arlington, N.J. to P.O. Box 134, Essex, Conn. 06426. . . . My addresses are stabilized and I will be most happy to hear from you at either. **Alice H. Kimball,** Secretary, Apt. 8-6C, 100 Memorial Drive, Cambridge, Mass. 02142 or P.O. Box 31, West Hartland, Conn. 06091

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Bill Wold retired from William C. Wold Associates, Aircraft firm, in 1968 and is now located in Conway, N.H. He just joined Rotary International and is leasing helicopters and investing in small businesses in New Hampshire. Bill is in the process of building a new home in Madison, N.H. He is a member of the National Baha'i Properties Committee and is President of New Era Properties, Inc., a Baha'i Faith oriented company. . . . **Phil Dreissigacker** has been appointed vice president of engineering for the Farrel Company, Division of U.S.M. Corporation. Phil has been employed by Farrel since graduating from the Institute and in 1957 was appointed manager of general product sales, and in 1965 was appointed chief engineer, (Ansonia-Derby), the post he held until his assignment as vice president of engineering. . . . Mrs. **Margaret M. Kingman** during the summer of 1970, directed the third workshop in non-visual perception of the environment. Eight blind and eight sighted students mapped "sound discomfort zones" in planned recreational "open space" areas in the Berkshires. . . . **Milton Lief** writes that his son, Lawrence, is a freshman at Cornell Medical University College in New York City; his daughter Debra "is a senior at Columbia College in Columbia, Mo., and the other daughter Anne, is still living at the Brooke House in Brookline, Mass., and working at Beth Israel Hospital as a medical technologist. Rose and I are alone but fine."

Fred J. Altman has been attending meetings in Tucson and France and writes that "Nice is nice." . . . **Norm Matthews** writes, "our younger daughter, Judith, is now a recreation director at a U.S. Army Service Club in Schwabisch Hall, Germany. She will be home for a few days to be married on June 26. I keep busy trying to keep the government from spending money needlessly on materials research." . . . Your secretary has received an announcement of the marriage of Mrs. Mary Kirby Casey and **Robert John Brauer** on the fourteenth of March 1970. Best wishes Bob.—**Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Curtiss Powell,** Assistant Secretary, Room 5-325, M.I.T., Cambridge, Mass. 02142; **Jerome Salny,** Assistant Secretary, Egbert Hill, Morristown, N.J.

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Your secretary has committed the unforgiveable sin of mislaying this month's news. This is appearing in order to avoid breaking a perfect record for 1938 class notes. In the future, I promise to be more careful and will treasure any communications from you until they appear in print.

In the meantime, if you haven't placed your reservation for homecoming days June 6 and 7, please do so and I will see you then.—**A. L. Bruneau, Jr.,** Secretary, Hurdman and Cranstoun, Penney & Co., 140 Broadway, New York, N.Y. 10005

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Charles F. Hobson sent along this good news item, that **Bernard G. Tremblay** was recently appointed president of the Ward Leonard Co. in Mount Vernon, N.Y. Bernie had previously been vice president and division manager of Federal Pacific Electric Company, in Newark. . . . And thank you, Charlie, for your thoughtfulness in picking up and forwarding Bernie's good news.

John N. Hobstetter has been named Associate Provost for Academic Planning at the University of Pennsylvania, in Philadelphia. John joined the University faculty in 1958 as an Associate Professor of Metallurgy. His promotions since that time have included: Professor of Metallurgy, Director of the Laboratory for Research on the Structure of Matter, Vice Provost for Research, and Dean of the Graduate School of Arts and Sciences.

The name of the late **Harry Wexler,** who served as director of meteorological research for the U.S. Weather Bureau, and who was an authority on weather satellites, was given to a crater on the far side of the moon. . . . **Robert L. Van Nice,** senior research associate of Dumbarton Oaks, Washington D.C., has spent thirty years studying the Mosque of St. Sophia in Istanbul.—**Oswald Stewart,** Secretary, 3395 Green Meadow Circle, Bethlehem, Pa. 18017

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George Stoner was one of the panel members on Low Cost Space Operations at the March 15 meeting at A.I.A.A./N.A.S.A. Space Shuttle Conferences. . . . *Forum* for January-February 1971 contains an article on "Superblock: New Life on the Street," designed by **I. M. Pei**'s firm in Brooklyn's Bedford-Stuyvesant area. . . . **Tom Hayes,** Course VI-A S.M. was elected a Fellow of the I.E.E.E. for his contributions in planning and development of energy systems.

W. H. Krome George was appointed to membership of the newly formed Commission on American Shipbuilding by President Nixon. The commission is to review the status of the American shipbuilding industry and determine whether subsidy payments by June 30, 1976 can be held to not over 35 per cent of U.S. construction costs. . . . **Bruce Duffett** writes: "You should like to mention to our classmates that **Charlie W. Freeman,** DEKE and Course XV man in our class, suffered a stroke—a cerebral hemorrhage—last fall and has been recovering in the sunny climate of southern California. The diagnosis for complete recovery is good and he will be back in the saddle this summer. Charlie has been vice president of M.F.B. Mutual Insurance Co., Los Angeles, Calif. He is also involved in a small business enterprise with **Al Barton** of our class. On April 8 the class of '40 will hold its second annual telethon for the Alumni Fund and at this point in time we expect to have Ed Kingsbury, Jim Gilman, Bill Stern, Herb Weiss, John Vanderpool, Phil Stoddard, Ed Bernard, John Danforth and Marty Abkowitz present."

Massimo Baer has been appointed to the position of Senior Science Fellow by Monsanto in recognition of his work on polymers, primarily in the field of styrene, acrylonitrile and vinyl chloride polymers. Massimo is the patentee of over 50 U.S. patents. He lives with his wife and two children at 49 Eunice Drive, Longmeadow, Mass. 01106. . . . **Leo Shufrin** was chairman of the membership drive of the Men's Associates of Jewish Memorial Hospital in Brookline, Mass. Leo's regular job is as an accountant for the U.S. Internal Revenue Service. Which is a reminder to your secretary that he has not filled out his income tax form yet.—**Alvin Guttag,** Secretary, Cushman, Darby & Cushman, 1081 K Street N.W., Washington, D.C. 20006

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Herbert R. Moody has been named president and general manager of Micromedic Systems, Inc., Philadelphia, Pa., manufacturer of microanalytical instruments. Before his appointment, Herb was assistant general manager of Micromedic Systems. Before joining Micromedic Systems, he was assistant plant manager of the Houston plant of Rohm and Haas Company, Philadelphia, Pa., manufacturer of chemicals and plastics. Prior to this he was assistant director of research in the Research Division of Rohm and Haas Company. Herb's present position is the culmination of 30 years of research and production experience in the chemical industry. He resides with his wife and their two children in Philadelphia.

David L. Shapiro is the author of an article, "Multiphasic Health Testing," appearing in Volume 23, No. 3, 1970 issue of *Sperry Rand Engineering Review*. Multiphasics is defined as the performance of a group of tests on an individual to obtain information on a plurality of possible diseases as distinguished from uniphasics which applies to tests to detect a specific single disease. The article discusses the data system developed and designed by Sperry Rand for application in multiphasic health testing centers (M.H.T.C.'s) which are appearing in various parts of the country. Dave attributes the increasing number of such centers to reduction in cost of multiphasic testing due to developments in automated laboratory equipment for clinical data gathering inexpensively and to developments in automatic data processing equipment for feeding test data to a computer which organizes it into a comprehensive report. Dave is currently a project manager in the civil and industrial systems area at Sperry Systems Management Division, Great Neck, N.Y. In this capacity he is concentrating on the multiphasic health testing concept and the design and development of related equipment. He joined the company in 1950 as a project engineer and was advanced to senior engineer in 1954, research engineer in 1955, research section head in 1958, and to senior research section head in 1965. In 1967 he served as project manager on an avionics system study and was subsequently assigned to an ocean systems group, where he was concerned with investigations of submarine countermeasures feasibility of passive ranging between submarines and the integration of oceanographic ships. Besides his B.S.E.E. from M.I.T., he has done graduate work at Columbia University and Brooklyn Polytechnic Institute. He is a member of the Association for the Advancement of Medical Instrumentation and holds two patents.

David P. Herron has been named president of Aerojet-General Corporation's Industrial Systems Division, a Maryland-based company specializing in automated material handling systems, and a major supplier of automated systems for the Post Office, warehouses, and transportation terminals. He was formerly director of F.M.C. Corporation's machinery/systems group. In previous years, he had been a vice president of Atlantic Research Corporation and had held executive posts with American Standard's Advanced Technology Division and Pillsbury Mills. He holds a B.S. and M.S. degrees from M.I.T. and a master's degree in business administration from Harvard University.

Mitchell Marcus, president of Boston Chapter of American Technion Society, made a report to that organization on his recent visit to Technion, Israel's Institute of Technology in Haifa. . . . **Joseph G. Gavin, Jr.** has been made a Fellow of the American Institute of Astronautics and Aeronautics for "notable and valuable contributions to the arts, sciences, or technology in his field." . . . **Howard J. Samuels** has been re-elected to the Board of Trustees of Franklin Pierce College.—**Walter J. Kreske,** Secretary, 53 State St., Boston, Mass. 02109; **Everett R. Ackerson,** Assistant Secretary, 831 Cranford Ave., Westfield, N.J.; **Michael Driscoll,** Assistant Secretary, 63 Center St., Nantucket, Mass.

H. R. Moody, '41

D. P. Herron, '41

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Every day that passes brings the 25th reunion closer. Less than a month remains before those important dates of June 4-7, 1971. One of the highlights of the reunion will be the class gift to M.I.T. Our goal is $400,000 and up to the publication date of this issue we had only reached $165,000. The class gift is important for the class and something in which everyone should participate, even if it is for a small amount. I believe the class gift is even more important and significant today than in past years. Today colleges and universities like M.I.T. have suffered a reaction from their alumni because of the minor incidents at M.I.T. and the larger incidents at other schools. In these cases small groups of students plus larger numbers of non-students have created confrontation and incidents at the schools. These incidents should not cause alumni to turn off the school and hold back their support to the schools. M.I.T. needs the support of its alumni now more than it ever has needed them in the past. You should send a contribution today showing you are behind the school, and that you do care.

The planning for the reunion is complete and we are very pleased to provide the details of the activities for the reunion weekend. Classmates should arrive in the mid-afternoon of Friday, June 4, or later if that is necessary. While the class has not scheduled any official activities prior to mid-afternoon, the M.I.T. dormitory and eating facilities will be available prior to mid-afternoon Friday for those who will arrive a little before noon on June 4. Registration will be done at Baker House beginning at 4:00 p.m. on Friday, June 4, as we all will be living at Baker House. We will have a bartender for cocktails that evening, and a meal will be served.

Saturday morning breakfast will be served from 7:30-9:30 a.m. A meeting coordinated with other classes will be held from 10:00 a.m. to 12:00 noon Saturday morning. This meeting will be a panel discussion meeting and will include the new president of M.I.T. and several other M.I.T. officials. The principal topic will be a review of current M.I.T. activities and include the chal-

lenges of the future. If sufficient interest develops the topics discussed this Saturday morning could be pursued further in smaller discussion groups Saturday afternoon. There will be a reception Saturday at the home of President-elect Wiesner from noon until 1:00 p.m. This will be followed by a luncheon with faculty members.

The class banquet will be held Saturday evening in the new M.I.T. Student Center. We will use the large function room, Sala de Puerto Rico. The banquet will be preceded by a cocktail party and if the weather is favorable, the cocktail party will be held out-of-doors. Saturday evening entertainment will include a band, which will probably be at the Student Center, from 8:30 p.m. to midnight. The five reunion classes have arranged for a program from about 10:15 to 11:00 p.m. by an experienced Cambridge theatrical group known as "The Proposition." This group has had excellent reviews and specialize in pertinent and topical improvisations.

Sunday morning will begin with breakfast at Baker House. There are numerous churches of all denominations in the neighborhood as we all know from our days at M.I.T. A Sunday afternoon picnic has been arranged by C. S. Lyon. The picnic will be held in Duxubry, Mass., near Plymouth. Duxbury has some very attractive beaches and this picnic should be a fine affair. Sunday evening is M.I.T. night at the Boston Pops at Symphony Hall. We have an area of 200 seats on the floor for adults and seats at lower prices are available on the second balcony for the children. The Monday Alumni Day program is being planned by the M.I.T. people and will give particular attention to a tribute to James Killian who will be retiring. The program will include a number of well known scientists, engineers and others to consider the subject of "Science and Public Policy."

Please keep in mind that special programs are planned for our children. For the younger children there will be camp-style activities under the close supervision of Jack Barry and his associates. Another interesting program will be arranged especially for the "young adults." We therefore urge everyone that is coming to bring their children, for these special programs are being arranged just for them.

For those of you who have not made plans to attend the Reunion, we urge you to do so. It is not too late. Please write a note right now to Ned Tebbetts, 9 Jerusalem Road Dr., Cohasset, Mass. 02025 and tell him you can come. Be sure to inform him how many are coming. See you at the Reunion.—**Russ Dostal,** Secretary, 18837 Palm Circle, Cleveland, Ohio 44126

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We have just returned from a very enjoyable week of skiing at Mt. Tremblant in the Laurentians. The snow conditions really ran the gamut from white ice known affectionately to the Easterners as hard pack to twenty inches of light powder and a little corn mid week. . . . The mail is rather thin but **Ben Brewster** writes that Ben Jr. is now a junior at the Institute. . . . **Abbot Fletcher** advises that he is production manager mechanical of Bath Iron Works in Maine. . . . **Norman Brown** is presently with the Office of the Foreign Secretary, National Academy of Sciences. In this capacity he is working to develop a program of innovative applications of science and technology to problems of international development.

The clipping services inform us that **Willis Reals** is now general manager—international of Texaco's supply and distribution department moving up from assistant general manager. Willis received his master's from the Institute in 1949 and joined Texaco in Lawrenceville, Ill. In 1960 he went to New York as a staff process engineer then to London in 1963. He was named general manager of supply and distribution there in 1967 and returned to New York in 1968. . . . We received a request from the *Review* to limit our class notes to a printed page which I find rather humorous. Please write so maybe we can fill a column!—**Dick O'Donnell,** Secretary, 28516 Lincoln Rd., Bay Village, Ohio 44140

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Albert J. Kelley, Dean of the School of Management of Boston College, last month became the Chairman of the Board of Economic Advisors to the State of Massachusetts. This group will advise Governor Francis Sargent on the effect of economic development within the state. . . . A news release from the A.I.A.A.'s 7th Annual Meeting gave us a picture of **Erik Mollo-Christensen** delivering his Von Karman Lecture. . . . From an Alumni Fund envelope, some brief information about **Buckley Collins,** owner of Collins Engineering Company, Port Huron, Mich. He proves it isn't all business with him, and the community has a place, as he has been a city councilman since 1965, and also has acted as regional chairman of the Michigan Municipal League.

Harrison E. Rowe has recently been honored by being elected a Fellow by the Board of Directors of the Institute of Electrical and Electronics Engineers. Membership as a Fellow is the highest attainable, and is by invitation only, being conferred only on those with the most outstanding qualifications. Dr. Rowe joined Bell Labs in 1952, and is in the Radio Techniques Research Department at the Crawford Hill Laboratory in Holmdel, N.J. He has authored numerous articles and one textbook in his field. . . . **Bernard M. Gordon** has been named as recipient of the New England Award for his outstanding contributions to the engineering field. Mr. Gordon has been awarded over 100 patents for his inventions in various electronics areas. He has lectured both at M.I.T. and Northeastern University, and has presented over 20 technical papers, many of them basic to the data processing field. Mr. Gordon has founded two companies, and several partially-owned subsidiaries where as technical director he is active in engineering design and engineering management. He is presently general partner of Gordon Engineering Company, Wakefield, Mass., an electronic design consulting company. Among his other awards he has received the Bausch & Lomb Science Award and the National Telemetry Prize for best technical presentation in telemetry.

Advanced Digital Systems, Inc. of Mohawk, N.Y. has named **Norbert E. Andres, Jr.** as director of marketing. The company is engaged in the development and manufacture of automated magnetic tape library management and transport systems. Previously Mr. Andres was with Cogar Corporation as general manager of the information systems division. Mr. Andres has had an interesting scholastic background, having received a B.S. in electrical engineering from M.I.T., a master's in business administration from the University of Michigan, and having studied law at Boston College for two years. He has spent over 20 years in the field of marketing and management in other computer oriented companies. Mr. Andres and his wife and six children now live at 20 Woodstream Court, New Hartford, N. Y.

Max O. Urbahn Associates, Inc. of New York City has announced the appointment of **J. Karl Justin** as vice president and director of project administration. Mr. Justin has worked for this company since 1969, and previous to that had had several years experience in architecture, engineering and building products development. He holds degrees in engineering and management, and studied architecture at Pratt Institute. Mr. Justin and his wife and son live at 520 East 76th Street, N.Y. Urbahn Associates have been active in the field of architecture and planning with a forward look for 25 years. Mr. Urbahn was managing partner of the joint venture that built "the world's largest building," the Vehicle Assembly building at Cape Kennedy. The company's services range the full field of architecture today, from the design of public buildings and special projects, to the more sophisticated areas of master planning and feasibility studies.—**S. Martin Billett,** Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

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We have some sad news this month: **John D. Eichenberg** died December 9, 1970. He lived in Pittsburgh and worked for Westinghouse Electric. In the 1967 Alumni Register, John was listed as Supervisor, Hot Lab, Bettis Atomic

Power Lab. I have no other information now.

Fortunately, there is some happier news as well. As of February 15, **Russell N. Cox** became president of General Investment and Development Company in Boston, which designs, constructs, owns, and manages apartment developments. They have units in Pittsburgh and on Long Island in addition to four in the Boston area. Russ will no longer be active in management, but will retain a financial interest in Linnell and Cox, Inc. . . . When I talked to Russ about his new position, he also noted that he had recently dined with the **Jack Barrigers**, who moved to Chicago shortly, and that Paula and **Milt Bevington** have just produced another son, the sixth out of a total of seven children. Is this now the class record? Anyway, congratulations. . . . An Alumni Fund note from **Ernesto Zapata H.** reports that he is manufacturing director of Ecopetrol (the Colombian National Oil Company) and directs refining, petrochemical and pipeline activities.

On February 7, **Earl W. Eames, Jr.** was elected vice president of Reed, Cuff and Becker, the management services subsidiary of Reed, Cuff and Associates, both in New York City. Earl will head the subsidiary, with responsibilities for management consulting, executive search and deployment activities. He had been a senior associate with Cresap, McCormick and Paget. Earl also gave testimony to his busy life, as follows: "Hope you enjoyed St. Croix. My wife, Anyes, spent a couple of weeks in Barbados last fall, but all I managed was a three week stay in upstate New York at the lake we all enjoy so much." St. Croix, as always, was beautiful and relaxing, Earl. (This year, I returned sporting a full beard, which I just may keep.) I am now fighting a miserable cold and wish I were still there.

Also in February, **Bert R. Chenault** became managing director of Badger Limited in London. Bert has had a long career with Badger, a subsidiary of Raytheon Company. He spent eleven years as manager of the Houston office before joining Badger Ltd. as director of sales and later as deputy managing director. Bert is a registered professional engineer in Texas and Louisiana with extensive experience in petroleum and petrochemical process, project and engineering assignments. . . . **David R. Israel** has been appointed as director of the newly created Office of Systems Engineering Management in the Federal Aviation Administration (F.A.A.). In his new position, Dave will supervise all F.A.A. systems engineering, management and integration, with particular emphasis on improvement of the air traffic control system. Godspeed, Dave, from me and all other heavily travelled classmates.

A second release from Raytheon announces that **Stanley Fay** is the inventor of an improved gyro stabilization system which eliminates "cross-coupling" error with a resultant improvement in measurement accuracy in applications such as space vehicle guidance. Stan has three children, 12, 8 and 6 and lives in West Roxbury. . . . That's all the news in hand. By now, all classmates should have received **Ira Dyer's** letter describing our hopes for our 25 year gift objective: "49 Visiting Professorship"; goal, $500,000. Don't forget, what you give this year counts toward the 25th gift. Give what you can. My best to all.—**Frank T. Hulswit,** Secretary, 77 Temple Rd., Concord, Mass. 01742

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Gene Babb returned to M.I.T. for a year to get his master's at the Sloan School. He is now back with Hughes Aircraft Co. as missile systems marketing manager. He and Clancie have two daughters, Bobbette 8, and Lynne 6. . . . **Roy Benjamin** reports from Tenafly, N.J., that he is helping to push the unemployment rate beyond 6 per cent. . . . **Lawrence Bray** lists among his activities: president, Wisconsin A.I.A.; Wisconsin Registration Board, Architects and Engineers; director, Sheboygan Chamber of Commerce; and secretary-treasurer, Wisconsin Association Professional Engineers and Architects. He and Lynn have had seven children, Larry 21, Greg 17 (deceased 1968) Patti 17, Geof 15, Holly 13, Lori 6, and Janine 4. . . . **Dwight Brown** is on the technical staff of Mitre Corp., Bedford, Mass. He is living in Nashua, N.H., with his wife Marie and Althea 20, Lois 18, Dwight Jr. 17 and Rosalie 11. . . . **William Brown** is with Southern Division, Naval Facilities Engineering Command, U.S. Naval Base, Charleston, S.C. and lists his hobbies as Church, Masonic Order, ham radio and fishing. He and Alice have four daughters, Betsy 18, Patty 17, Barbara 14, and Gayle 13.

Again we have the sad duty of reporting the death of a classmate. We were notified that **Griffith May** of Penfield, N.Y. died November 5, 1970. We have no further details. I'm sure we all share in sending our sympathies to his family.

Gilbert Cook is a staff engineer at Martin Marietta in Denver where it's only a short ride to the ski slopes. He and Ann have three daughters, Katherine 18, Harriet 16, Henrietta 14. . . . **Walter Cook** is still with the Foxboro Co., Foxboro Mass., and is enjoying sailing and flying. . . . **Henry Hall** is a frequent contributor to the *General Radio Experimenter* and recently authored an article "Another Traceability Path for Capacitance Measurements" on the calibration of rf-capacitance measurements traceable to N.B.S. . . . **Kenneth Holmes** is still with Johnston Service Co., but is now in Georgetown, Ky. where he is operations manager. He and Rosamond have two children, Rene 23, Dana 13. . . . **Robert Knopf** has been promoted to Lieutenant Colonel U.S.A.F., Fairfax, Va. He and Barbara have three daughters Kathy 9, Patty 7, and Lisa 6. . . . **Robert Lord** has been transferred to London and the family is living in Purley. He is managing director of Atlantic Oil Producing, a subsidiary of Atlantic Richfield. . . . **Martin Murphy** is an associate of Haley and Aldrich, Inc. a soil consulting firm incorporated in 1962.

Melvin Rubin, Course I, is now with LeMessurier Assoc., Inc. in Cambridge, Mass. as a structural engineer. . . . **Sander Rubin** is now a vice president of Scantlin Electronics, Inc. in charge of systems design and programming for the Financial Information Services Division.

Jim Russell reports from Lincoln, Mass. that he is owner and president of Minute Man Engineering Corp., general contractors, and finds time for coaching Pony League baseball and hockey. He and Marguerite have four children, James Jr. 14, Leigh 13, Karen 12 and Neal 11.

Gordon Shaw has recently received an M.S. in management from Northern Illinois University. . . . **David Sparling** is now vice president—finance for Philco-Ford, Newtown Sq., Pa. He and Anne have four children, Debbie 16, Lisa 15, David 12, and Laura 10. . . . **Louis Tedeschi** and his wife Janet reported the arrival of Conrad on June 2, 1970. He joins brother Francis and sister Maria in their Santa Monica home. Lou is a member of the technical staff working on orbit determination and prediction studies for Aerospace Corp., El Segundo, Calif. . . . **Daniel von Recklinghausen** authored an article "High Fidelity Electronics" in the *I.E.E.E. Student Journal* describing the operation of a 35-watt stereo amplifier using silicon pushpull pnp-npn power transistors, F.E.T.'s and I.C.'s. He is now technical director of H. H. Scott, Inc.

Among the 1970 homecoming attendees were the following '51 members; William and Mrs. Cavanaugh, Sam and Mrs. Greco, Marvin Grossman, Arthur and Mrs. Heineck, Charles Hieken, Fred Lehmann, Gerald and Mrs. Marcus, Samuel Rubinovitz, and Daniel and Mrs. Sullivan. . . . The reunion has brought an almost overwhelming response. (If you still haven't paid your class dues send $7.50 to Treasurer **Fred Aldrich** or your class secretary for forwarding.) Indications are that we will have our usual record-setting crowd. Since this was written well before May, we hope that you signed up early! Here is some news from a few of those who plan to attend the reunion: **Albert Cohen** wrote: "Same as before: Wife Anna, three children, all girls, am still president of a small company in Concord, Mass., Electronic Space Systems Corporation; reside in Stow, Mass., and *hope to see you all at the reunion*" (Italics mine—secty). . . . Nothing new to report for **George Colvill.** The status is quo in Houston. . . . **John Dennis** was appointed assistant vice president of Metcalf and Eddy. John lives in Needham, Mass., and has been an active civil engineer. His forte is water pollution control. . . . **Charles Ellis** is director of engineering at Boeing Vertol outside of

Philly, and in 1970 he was appointed consultant member of the Army Scientific Panel. His family are still ardent skiers and campers. Children are growing up: Kathy is a sophomore at the U. of Chicago. Steve is an Eagle Scout and a senior in high school and has applied to M.I.T., and John, in his freshman year in high school is a budding artist.

J. Franklin Koehler completed his fourth year in Belgium with Esso Chemical S.A. . . . and Dr. **Clint Seeley** is still practicing radiology in Andover, Mass., during "the waning years of freedom for medicine," and concludes with our conclusion for this month: Hope to be at the reunion with you.—**Paul Smith,** Assistant Secretary, 11 Old Farm Road, North Caldwell, N.J. 07006; **Howard L. Levingston,** Secretary, 358 Emerson Road, Lexington, Mass. 02173; **Marshall Alper,** Assistant Secretary, 1130 Coronet, Pasadena, Calif. 91107; **Walter Davis,** Assistant Secretary, 246 Forest Ave., Brockton, Mass. 02402

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Your Secretary has just returned from winter vacationing in Bermuda. Arline and I enjoyed ourselves so much that we think Bermuda would be the ideal place for our class' upcoming twentieth reunion. I have discussed this with our Class President **Bob Warshawer** and we now would like your views. When next you write with your news, let us hear your thoughts, as the reunion is only three years away and such plans have to be made two years in advance.

Peter Katchis reports that he is now with General Electric Pension Trust, responsible for security analysis and portfolio management; **Edward T. Brandt, Jr.** is in financial analysis with I.B.M.; **Gerald Fahringer** is group vice president for Riker Maxon; **King Kraft** at General Radio working in microwave; **Joseph Clark** with Holyoke Water and Power Co.; **John Blair** at Raytheon's Research Division; **Stan Wolk** still with Pittsburgh Plate Glass managing P.P.G.'s Ford City Plant and the Twindow Works at Creighton, Pa.

Emmanuel Otis is vice president and general manager of the computer systems and development group of Control Data Corporation. . . . **Jerry Perry** reports the recent birth of his son, David Frank Perry. . . . **Joseph Scheller** has again been elected President of M.I.T. Club of Lehigh Valley. . . . **Perry Smoot** in his spare time has been giving lectures on astronomy to his son's schoolmates at night, under the stars.

Richard Wilson has taken over the family book bindery business. . . . **John M. Peterson** has been named administrative assistant to the president of International B.F. Goodrich Co. in Akron, Ohio. John has been with Goodrich since 1965. Since leaving the Institute he acquired a law degree from the University of Akron, and is a member of the American Bar Association. Pete is fondly remembered to have a legalistic mind even back in Baker House days.

Hank Hirsch on the faculty of the University of Kentucky College of Medicine is taking his sabbatical leave studying aging at the Brookhaven National Laboratory. Hank has been elevated to Colonel in the Honorable Order of Kentucky Colonels, a rare distinction he reports—"for a country boy from the southern part of Westchester County, New York."

As I look out of my study window at two feet of Massachusetts snow, my thoughts again turn to a reunion in sunny Bermuda, so let me have your news and thoughts on this.—**Harvey Steinberg,** Secretary, 273 Singletary Lane, Framingham Center, Mass. 01701

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May reminds me of marriage. Depending on your circumstances that may evoke sighs or smiles, but I've had three happy years. The other eleven weren't bad, but sometimes I wonder if we're well matched. Like, say, Sara Mae and **Lawrence Berman.** Larry was captain of the cross country team while at Tech, and he has continued competitive running since then. Sara became interested in the sport, and she has held the title of New England Woman's Cross Country Champion for the past four years. They now travel to events with their children, Penny, Alexander, and Jonathan, who also run a mile a day. Between meets the Bermans make their home at 23 Fayette St., Cambridge, Mass. . . . A note from **Joseph A. Clumpner** describes the city of Beirut as noisy and not the easiest place to raise three children. Joe enjoys teaching at the American University of Beirut. He and his family live in faculty housing, two blocks from the beautiful campus.

Leo M. Keane has written a paper for N.A.S.A. titled "Global Navigation and Traffic Control Using Satellites," which describes a systems approach for the use of satellites to support a large number of users with multifunction requirements.

Robert C. Grout has been appointed to the position of E.D.P. systems coordinator for the Eastman Kodak Company. He and his wife Joan have three children and live in Rochester, N.Y. . . A short note from **Oswald F. Fuzzer** mentions that he has left his position as ecology consultant for the Secaucus Beautification Commission, and that he plans to travel extensively as a salesman for a mideast exporting firm. Incidentally, his wife Mona, just had their twelfth child, and he wants to know if this is the record for the class. If you have any records or news that you would like to share with the class, please drop a note to—**Allan C. Schell,** Secretary, 19 Wedgemere Ave., Winchester, Mass. 01890

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Just a short set of notes this month. Last call for the 15th Reunion at the Harbor View on Martha's Vineyard, June 4-6. Still time to rush a call to Bill Grinker or any one else on the committee.

Paul Luckett has been named executive vice president and general manager of the Beaunit Fibers division of Beaunit, a subsidiary of El Paso Natural Gas. Paul has worked for El Paso and El Paso Products since graduation and had recently been a vice president. . . . **Bill McNulty** has been elected director of engineering I.T.T. World Communications in New York. . . . **Ed Pease** recently wrote that he managed to visit Japan and spend a month in remote areas of Thailand last year. . . . **Ken Randolph** is special assistant to the Head of the Chemical Engineering Department at Tech. One of his assignments is to establish an interdisciplinary enzyme laboratory. Ken had been with the Department of Interior directing work on fish protein concentrates.

Mickey Reiss is president and founder of Alarmtronics Engineering Co. As such he recently testified before a Congressional Committee on security systems. Mickey also was head of the Greater Boston campaign to raise money for Cerebral Palsy in 1971. . . . At the 7th Annual meeting of the American Institute of Aeronautics and Astronautics, **Russ Schweickart** could be seen swapping yarns with his counterparts from Russia.—Cosecretaries: **Bruce B. Bredehoft,** Box 181, Dover, Mass. 02030; **T. Guy Spencer, Jr.,** 73 Church St., Weston, Mass. 02193

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News is very sparse this month. There are only a few scraps in the mailbag. **Dave Stuber** wrote us the following note: "I am still in the Air Force, current grade of major. I received my Ph.D. in metallurgical engineering at Ohio State University in 1968 and am now an Assistant Professor at the Air Force Institute of Technology. We have four children ranging in age from nine years to one year—three girls and, the youngest, a boy." . . . **Bruce Blanchard** says he is still on the staff of the Department of the Interior, which, in view of all the head rolling that went on a while back, is real news. . . . **Alex Bernhard** writes that his family moved to a home in Ipswich that according to the town's historical society was built before 1687. Their third son was still with Bingham, Dana and Gould (a Boston law firm) working in banking and investment law as counsel to the investor.

That's all except for a few notes I picked up over the phone from **Andy Blackman** when I was in New York for a brief visit in February. As many of you will remember from a note two years ago,

Andy and his wife are both designers, Andy doing mainly showrooms and offices, his wife, fashion. They purchased a brownstone, live in the top three floors and operate their business in the lower two floors. Some of Andy's recent commissions include showrooms for J. P. Stevens, Bamberger's department store, Macy's and Garland Corporation. Andy passed on the news that **Peter Samton** is with Gruzen and Partners, the New York architectural firm. . . . Next month's news will come from Russia. Betty and I will be travelling there on holiday at deadline time.—**Frederick L. Morefield,** Secretary, Tirasaarentie 17, Helsinki 20, Finland

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Paul Kossler has been promoted to Senior Engineer/Manager of Advanced Systems Engineering at the I.B.M. Electronics Systems Center in Owego. Following graduation Paul spent several years with the U.S. Air Force and then joined I.B.M. in 1962 and has held a variety of engineering and management positions since that time. In addition to his master's in Course VI, Paul has also taken graduate study at Florida State University and at Syracuse University . . . U.S. Air Force Major **Allan Ramsay** has been decorated with the Meritorious Service Medal at the Manila Observatory in the Philippines. He was cited for his outstanding performance of duty as Assistant Chief of the Aerospace Projects Division, Air Weather Service at Scott Air Force Base. Currently, Allan is Chief of a Detachment of the 1st Weather Wing at the Manila Observatory. Although Alan and his wife, Bonnie, have been busy moving about the country, Allan has found time to pursue studies at Texas A&M University and the University of Colorado.

Spring is green and news is lean—send word that you are alive and well.—**Michael E. Brose,** Secretary, 199 Sudbury Road, Concord, Mass.; **Antonia D. Schuman,** Assistant Secretary, 22400 Napa Street, Canoga Park, Calif.

59

This past St. Patrick's Day eve, I joined eight of our classmates in the Alumni Office to participate in the 1971 Alumni Fund Telethon. A group of six classmates had shattered all previous Telethon records last year by placing 215 calls, completing 131 calls, and soliciting 113 pledges. In addition to spending an evening with classmates and being treated to a fine collation by the Alumni Office, the Telethons provide the opportunity to renew acquaintances with long lost fraternity brothers, course mates, and just plain friends—all on the Institute. It also provides the class secretary with some much appreciated fodder for the Class Notes and for those with a competitive streak in them, the opportunity to "beat last year's record." This year's group consisted of our esteemed class president, **Al Bufferd,** who is still keeping busy as research director at Nuclear Metals Division of Whitaker Corporation; Class Treasurer, **Chuck Staples,** who's now at MULTICOMP Corporation; **Dick Sampson,** now with Colonial Management Association, Inc.; **Pat McGovern,** President of International Data Corporation; **Shel Buck,** who's still at the Draper Labs and has recently moved to Brookline; **Larry Laben,** with I.B.M.; **Bob Williamson** with the Foxboro Company; **Ron Stone** who's recently returned to M.I.T. as Executive Officer of the Graduate School and me!

Among the interesting items gleaned from telephone conversations with either classmates and/or wives are the following: **Jeff Winicour** is currently a physicist at the Wright-Patterson Air Force facility working in the area of general relativity—and still playing some tennis! . . . **Bob Stalder** is teaching math at the Park School in Buffalo after getting a master's in math from the University of Buffalo. Bob says he loves teaching and enjoys living in Buffalo. . . . **Terry Kuroda** is married with two children, now living in Mt. Vernon, N.Y., and working for McKinsey & Co. . . . **Ted Schuh** is working for Nalco Chemical, is married and has one son, 6 years old. . . . **Bob Muh** was recently named Chairman of the Board of Newberger, Loeb & Co., Inc., a N.Y.C. brokerage house (congrats, Bob!)

Dick Talbot is still in the air force and working on a Ph.D. in flight dynamics at the Air Force Institute of Technology, Wright-Patterson A.F.B. Dick has been at W.P.A.F.B. for nine years, is married and has three children. . . . **J. Mike Ross** is in the land development business, building apartment buildings in Illinois. Mike has been married for one year. . . . **Jim Wishart** is a senior metallurgist at Island Steel in Chicago and has two sons.

For those of you who are wondering—we did manage to break last year's mark and set a new standard for other classes to shoot at. This year's marks were: 247 calls placed, 151 calls completed, and 115 pledges. Anyone interested in participating in this annual event can contact either Chuck Staples or the Alumni Office—your assistance is welcomed.

From the mail bag—a lean month—the following items: **Seiji Itahara** is currently director of engineering services at Reflector Hardware Corporation in Melrose Park, Ill., where he lives with his wife, Nell, and two children, Julie, 2½, and David, 10 months. Seiij left his previous position as manager of systems analysis at American Cyanamid in February, 1971. . . . **Carter Smith** writes that he's enjoying New England working as a computer scientist at Technology Management Inc. in Cambridge. He has only been back here for one year coming from Seattle, Wash., and is living in Newton with his wife, Dianne, and children, Dianna (8), and Stephen (2½). . . . **Jon Weisbuch** is currently Assistant Professor in the Department of Community Medicine, B. U. School of Medicine. Jon and Kathleen have a son, Joshua (10 months). Jon writes "John Covington is in N.Y.—alive, well, and married! . . . **Ron Colier** is with Xerox Corporation in Los Angeles, Calif.

The peripatetic Cynthia and **Myer Kutz** (look that up in your Funk and Wagnall's) recently returned from a month's vacation in Israel. As with most visitors to the Holy Land, they became quite engrossed with the archaeological points of interest. Their description of the food in Israel was most graphic: "just awful." . . . I had a few drinks one evening recently with **Phil Richardson** who was in town checking out the Boston money markets in his position as investment banker for Lehman Bros. in New York City. Phil was excited about his recent purchase of a condominium apartment on the West Side and extends an open invitation for any of his friends to drop in for a drink when passing through N.Y.C. . . . I received a newspaper clipping which announced that **Clif Benzel** received the Master of Divinity degree from Gordon-Conwell Theological Seminary and that he had accepted the position of director of research and planning for the Evangelistic Association of New England. Clif was a teaching lecturer in physics and economics at Gordon College from 1966-69, and during the past year was assistant to the vice president for institutional advance for Gordon College and Gordon-Conwell Theological Seminary.

I received an interesting letter from **Ken Kawano** informing me that Ken, who is now a Major in the U.S. Army and stationed in Vietnam, has received orders to report to the U.S. Army Materials and Mechanics Agency in Watertown, Mass., for his next tour of duty beginning August, 1971. It will be good to have Ken and his lovely wife, Lillian, in the area again—welcome back! Well, that's about all for now. If you're good, there will be more next month. Until then, take care.—**Arthur J. Collias,** Secretary, 61 Highland Rd., Brookline, Mass. 02146

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Richard Queeney is still at Penn State University in the Department of Engineering Mechanics. Last year he and his wife announced the arrival of their second daughter, Katherine Lynn. . . . After receiving his Ph.D. in communications biophysics from M.I.T. in 1968, **Irv Thomae** assumed the post of Assistant Professor at Federal City College in Washington, D.C. He has organized and built up an engineering program, which now includes 5 faculty members and 350 students, and is chairman of the electrical engineering program. His wife, Sally is an assistant professor of chemistry at F.C.C. . . . **Jerry L. Adams,** Assistant Professor at Ohio University, is co-author of an introductory physical science text to be published this spring by D. C. Heath and Co. . . . **Robert Wilhelm** has taken up a new hobby of skindiving and spear-fishing in the Rosarios Islands near Cartagena. Bob

reports that these islands are some of the most beautiful in the world. Can't understand why he would possibly be interested in white, sandy beaches, coral reefs, crystal-clear water and multitudes of game fish. . . . **Robert Johnson** is currently a project supervisor in the Research Division of Rohm and Haas in Philadelphia. Bob was recently married to the former Carol Jean Winger. Carol is a graduate of Penn State University and teaches in a local elementary school.

John Banzhaf, 3rd is continuing his anti-smoking crusade in his role as executive director of Action for Smoking and Health. Though cigarette advertising will be broadcast no more, he is urging continuation of anti-smoking messages on the air and turning his attention to the magazine and newspaper front. John has recently been denied tenure at George Washington University, which he is contesting.

George Wright, architect, has recently been named an associate at Max O. Urbahn Associates, Inc. Before he joined the Urbahn firm in 1969, Mr. Wright had had some ten year's experience in project design and management. He has been a guest lecturer on systems analysis and architecture at City College of New York. George received his B.S. in industrial management from Yale University and his Bachelor of Architecture degree from M.I.T.—**Gerald L. Katell,** Secretary, 122 North Maple Drive, Beverly Hills, Calif. 90210

64

Well, classmates, I've reached the bottom of the pile of class notes clippings. Unless a few Class Heroes send me more news, the ole column will run dry! . . . **Michael Feuer** has completed his third year as an assistant professor in the M.I.T. physics department. His current hobby is building model rockets with his six-year-old twin boys. . . . **John Hanson** is now over half-way through his year as a White House Fellow. As one of 17 persons selected to serve with various federal departments, John has been assigned to the Labor Department. He has participated in top-level work with the Department and has learned a great deal about how government functions. At the completion of his year he will return to his work as a nuclear scientist for Westinghouse.

Lawrence Kaldeck is a senior mathematical scientist for Avco Computer Services in Wilmington, Mass. . . . **Albert Teich** is project director of a $87,200 grant from the National Science Foundation for a study which will establish guidelines for a national program of environmental research laboratories. The work is being conducted at the Policy Institute of Syracuse University Research Corporation. The column has now run dry! Let me hear from you.—**Ron Gilman,** Secretary, 5209 Peg Lane, Memphis, Tenn. 38117

65

The stock of clippings gets thinner and thinner, and this column necessarily follows suit. **Marty Goldsmith** was nice enough to help the cause by writing a letter. For which I thank him. Marty is presently a resident in radiology at the Tufts New England Medical Center. Marty and his wife Karen have a son named Michael who is nine months old. . . . A couple of other classmates also report additions to their families. **Stephen Deutsch** and his wife Karen report the birth of a daughter, Nancy Lauren, on January 15, 1971. . . . **David Slosberg** now has a second son, Adam Lewis, born last October.

A number of interesting professional activities also reported this month. **John Holdren** has coauthored with Stanford biologist Paul Ehrlich a series of articles on environmental problems for *Saturday Review.* They have also coedited a collection of papers titled *Global Ecology* published in March. John's principal occupation is still the controlled fusion program at Lawrence Radiation Laboratory. . . . **Chan Stowell** has moved to Minneapolis to work for the Pillsbury Company. . . . **George Moyer** completed his M.B.A. at the University of Washington in December and is now working for the First City National Bank in New York City. George has moved from Seattle, Wash. to Chatham, N.J. . . . **C. Julian Vahlberg** completed his Sc.D. at M.I.T. in June, 1970 and is now an Assistant Professor in Mechanical and Aerospace Engineering at Oklahoma State University. Julian reports the birth of a second child, a son, in July. . . . **Robert Chang** received his Ph.D. in astrophysics from Princeton in February. . . . **Amedeo Odoni** is an Assistant Professor at M.I.T. and will move from the Department of Civil Engineering to the Department of Aeronautics and Astronautics effective in September.

And that's this month's column. I'd like to have more to report but I can't do it without your help.—**Steve Lipner,** Secretary, 940 Belmont St., Watertown, Mass. 02712

66

The Halls of Academia are still filled with various members of our Class. **Tom Gomersal** stopped into my office about two weeks ago to fill me in on his movements. He is taking a master's in statistics at Colorado State University and will move on to Northeastern after that. . . . **Enrico Poggio** is finally finishing his Ph.D. at M.I.T. in theoretical physics. He will be a research associate for the next two years at Columbia University. On January 25, he became the proud father of a baby girl, Alessandra Pilar. . . . **Richard Clark** will graduate from the University of Rochester School of Medicine in June 1971 with an M.D. and an M.S. in microbiology. He is an honorary fraternity member of A.O.A. . . . **Hans Bozler** is still working on his Ph.D. in low temperature physics at Stony Brook. . . . And **Richard Williams** is now a third year medical student at the University of California at San Francisco.

The only person I have word of receiving a degree is **Martin Krone** who obtained a Ph.D. in electrical engineering from Princeton University in February. . . . **Keith Stolzenbach** has joined the Department of Civil Engineering at M.I.T. as a Visiting Assistant Professor until June. . . . **Joel Pratt** is now an assistant manager for the Control Systems Division of Applied Data Research, Inc., in Princeton, N.J. . . . Soon to return to Washington at the end of an assignment in the Foreign Service is **Timothy Carney.** So far he doesn't know what his new post will be when he returns in August. In the meantime he is planning a "photographic safari" to Botswana. . . . **Larry Daley** joined Celanese Research in September as a research engineer. On January 2 he was presented a son by his wife Kathleen. . . . I'm looking forward to seeing everyone at the Reunion in June and catching up on new wives, degrees, babies, jobs, and homes. See you then. Cheers!—**Terry J. Vander Werff,** Secretary, 2049 Manchester Dr., Fort Collins, Colo. 80521

67

Bob Howard came to California last month to visit a few people. It was good to see him again. I will fill you in on his activities after he sends me the official poop. This column will be a little shorter than usual because I have new information on only a few classmates. **James Warniak** is an infantry lieutenant assigned to a mobile advisory team in Vietnam. This five-man unit works with Vietnamese forces that are responsible for road and bridge security on a stretch of Highway 1. . . . **Gary Englander** left General Electric in October and is a senior electronics engineer at Norton's Machine Tool Division in Worcester. He designs control systems for production line grinding machines. . . . **David Dilling** has a son, Daniel Arthur, born December 30, 1970. . . . **Jeff Schoenwald** writes that he recently returned from fabulous skiing in Austria. Also, he has an article in the February 15 issue of "Applied Physics Letters."

Russel Perkins sent the following letter: "Shortly after graduation, I married the former Martha Ann LaPoint (V.C.U.'67). I went to work for the Department of the Navy, completing a three-year training program last June. The first year was spent at M.I.T. where I received my master's degree (XVI), the second year at Lockheed Aircraft in Burbank, Calif., and the third year at the Naval Air Development Center in Johnsville, Pa. I am presently working for the Naval Air

Systems Command in Washington, D.C. We are expecting our first child in May. During my travels, I crossed paths with several M.I.T. classmates. **Paul Tarantino,** a lieutenant in the U.S. Navy, serves in a P-3 A.S.W. patrol squadron. He is presently enjoying a balmy tour of duty in Adak, Alaska—noted for its evening fog that rolls in during the late afternoon and remains for the week. **John Patterson** is also a Navy Lieutenant and is presently stationed in Washington, D.C." . . . **Bob Steele** married Angela Fox of Sunnyvale, Calif., on June 27, 1970. Angela, a graduate of Berkeley and Stanford, teaches English. Bob is still at Berkeley in chemistry. He also teaches a course called "The Impact of Science on Society." . . . **James Walker** is director of Loran-C research at U.S. Coast Guard Electronics Engineering Center, Wildwood, N.J. He holds the military rank of lieutenant commander. He previously taught electrical engineering at U.S. Coast Guard Academy at New London. —**Jim Swanson,** Secretary, 774 Channing Ave., Palo Alto, Calif. 94301

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Welcome again to Gail and Mike's place. As usual, our location is here in scenic Cambridge with a breathtaking view of Kendall Square. Spring is slowly coming to our subarctic climate and the crocuses have blossomed among the traces of snow in front of Building 56. Our flow of mail has picked up somewhat this month with letters coming from Chile and Vietnam.

Class Hero

The class hero for this month is Lonna Baum. Actually Lonna went to B.U. ('68) but she had been trying for months to get her husband, **Alan Baum** to write and she finally decided to take the direct approach and write herself. This was a very meritorious idea and we recommend that other frustrated spouses of classmates take the same approach. Meanwhile, Lonna and Alan were married on September 8, 1968 and settled in Providence where Alan has been in the doctoral program in applied math at Brown. He passed his prelims last August and plans to receive his Ph.D. in June 1972. One happy interruption in his studies was due to the arrival of their daughter, Julie Ann, on November 3, 1970.

Vietnam Viewpoint

The following note was received from Lieutenant (j.g.) **Tom James** and is printed in its entirety as paraphrasing would not do it justice. "Well, here I am in sunny Saigon—can't tell you how happy I am to be here. Everything is really bad news. I have to sit in my air-conditioned office 11 hours a day and sweat out getting my stereo gear! That is between the gym and swimming pool." . . . Lieutenant **Phil Turner** is also in the service of his country, but alas he is stationed in more mundane Omaha. You might remember that last year Phil had some quaint comments about the mental ability required for his assignment. Things have picked up and now he reports that his assignment "has improved to the point of being livable." He is working with I.C.B.M. trajectory analysis programs on a 360/85. This winter he was able to get away and spend a week skiing in Aspen. . . . Military service does not last forever. **Robert Jacobus** will be coming back to Cambridge in June to enter graduate school at Harvard after spending "two *long* years in the U.S. Army." . . . **Brad Billetdeaux** has returned to Course X after serving a tour in the navy.

World Travelers

From Chile, **Jeff Reece** writes that he has left Berkeley and moved to Santiago with his wife Trudy. They welcome mail from old, lost friends addressed to Casilla 1287, Santiago, Chile. . . . **Art Kalotkin** spent a month in Japan last summer with Dale Laron '69. He reports "We bumped into a few Tech men over there! They're all over!" . . . **Barry Blumfeld** is now at CERN in Geneva. . . . **Bill Klauber** has moved to Vancouver, British Columbia where he is working as a geologist for Golder Gas Company. He and his wife Marge spent last summer camping in the western U.S.

Here and There

We bumped into **Ed Seykota** and his wife recently in downtown Boston. He is now working in New York City for C.B.W.L.-Hayden Stone, Inc. in their commodities research department after having been on the D.S.R. staff for a while. . . . **Ann O'Reilly** is working at Arthur D. Little. . . . **Richard Plotnick** has completed a Master's in mechanical engineering at the University of Pennsylvania and is still with Westinghouse Gas Turbine Division near Philadelphia. . . . **Bob McCrory** has been appointed Class Agent, replacing **Jerry Grochow** who continues to serve the Alumni Fund Board. Bob is back at the 'tute in Course XXII after spending last term with the Army Reserve. . . . That's all there is this month. We haven't missed a month in almost three years now. But to keep this up we need your help. Drop us a line soon. See you in June.—**Gail** and **Mike Marcus,** Eastgate Apt. 16A, 60 Wadsworth St., Cambridge, Mass. 02142

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Apparently our little friend the blue dwarf has been pointing his finger at several of our classmates because I have started to receive responses from those who have guilty consciences. You can remove your guilt feelings, avoid the accusing finger of the blue dwarf, and see your name in print just by dropping me a note at your earliest convenience. . . . Among those who fell victim to guilt feelings was **Michael J. Ginzberg** who has been working for United Nuclear in Elmsford, N.Y., since graduation. Although Mike's official title is systems designer, he has been doing a little bit of everything—from negotiating the purchase of a used computer system to programming financial analyses, counting proxies, and even collecting bills. Mike's other activities have included learning to be a pilot, getting his M.B.A. in economics from Iona College, skiing, and dieting (down to a trim 171 from 190). Evidently, Westchester county isn't the swingingest place to be if you are single. Mike reports that his social life hasn't been all that great since "both single girls in Westchester county are over 50."

Wedding bells have rung for the following: **Peter Eirich** exchanged wedding vows in June 1970 with the former Miss Leigh Dresser, '70, during a ceremony at which I was present. I can happily report that a good time was had by all. Pete and Leigh stayed in Boston during the summer while Pete completed his master's thesis. In the fall they moved to the new city of Columbia, Maryland, where Pete and Leigh report that they "like it very much." . . . **Geraldine Goldstein** has become the bride of Henry I. Miller, '68. She is a student at the University of California medical school in San Diego where her husband is studying towards his Ph.D. in biology. . . . Wedding bells will ring for **Leo D. Geoffrion** and Miss Donn Lynn Ellis in June. Leo is currently a grad student in physics at M.I.T.

I am happy to report the presentation of the L. F. Hickernell Award to **Roger Chang** for his prize winning paper "Reliability Analysis Programs for Electric Power Distribution Systems." The award was made at the winter meeting of the I.E.E.E. Power Engineering Society at the Statler Hilton Hotel, N.Y., on February 2, 1971. Roger is currently enrolled at the University of Michigan while serving on the I.E.E.E. meeting committee of the Southeastern Michigan Section. On behalf of our class, I extend hearty congratulations to Roger for his achievement.

Among short notes I have received the following: **Michael Laird** is attending the master's program at the Sloan School of management. . . . **Ka-Hung Fogg** is a graduate student in physics and a research assistant in astronomy at the University of Maryland. He is planning to do his Ph.D. thesis in astronomy. . . . **Joseph Steuert** finished his S.M. at the Sloan School in February after receiving his S.M. in physics in June of 1970. Joe married the former Miss Barbara Auman, Wellesley '68, in June of 1969. Joe and Barb are presently living in Lexington, Mass.

Recent word from **Larry Viehland** reports he is "still plugging away" toward a Ph.D. in theoretical chemistry at the University of Wisconsin. . . . **Andrew J. Fillat** is in the first year program at Harvard Business School. . . . **Andres E. Breiter** is a consultant with McKinsey-Milan in Milan, Italy. . . . **Hugh Olmstead,** is working for two years in England as a technical officer for Imperial Chemical Industries, Ltd.—**Richard J. Moen,** Secretary-Treasurer, 412 Hastings Hall, Cambridge, Mass. 02138

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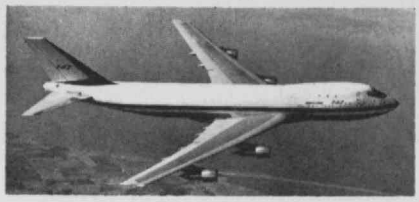

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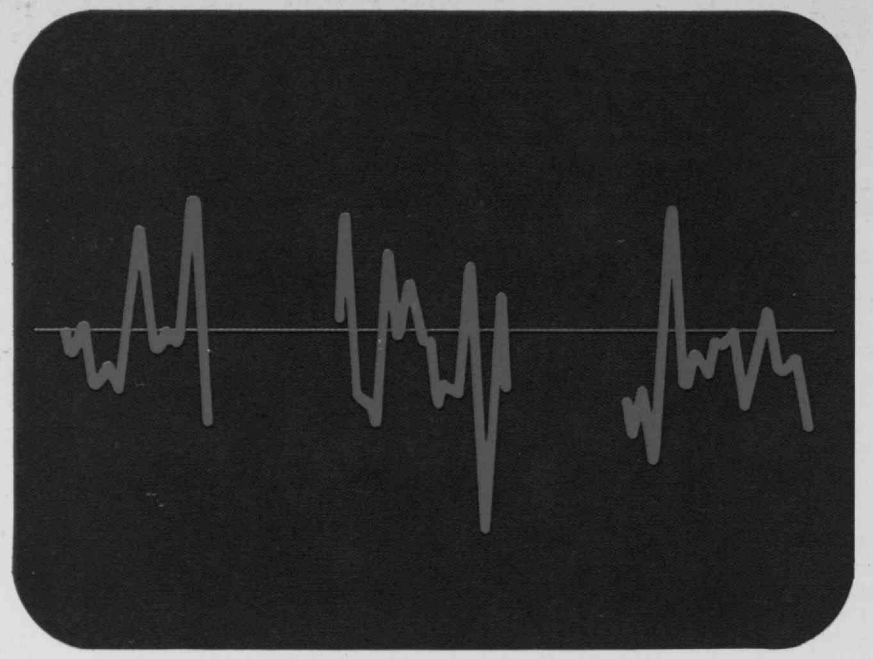

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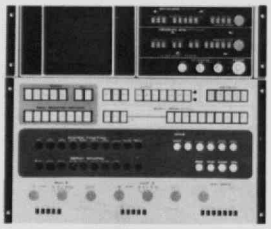

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